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INSTITUTE FOR SUSTAINABLE FUTURES

Institute for Sustainable Futures

OUR ENERGY FUTURE:

SSROC RENEWABLE ENERGY MASTER PLAN

2013

ABOUT THE AUTHORS

The Institute for Sustainable Futures (ISF) was established by the University of Technology, Sydney in 1996 to work with industry, government and the community to develop sustainable futures through research and consultancy. Our mission is to create change toward sustainable futures that protect and enhance the environment, human well-being and social equity. We seek to adopt an inter-disciplinary approach to our work and engage our partner organisations in a collaborative process that emphasises strategic decision-making.

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EXECUTIVE SUMMARY

Across the world renewable energy is changing the way citizens and organisations think about and use energy. Decreasing costs and increased deployment of renewable energy are changing the way our energy systems operate. Councils, as both large energy users and facilitators of local action are playing an increasingly important role in this renewable energy transition.

The *Our Energy Future: Renewable Energy Master Plan* process brings together eight pioneering councils in southern Sydney and the Institute for Sustainable Futures to identify a range of practical and cost effective actions and delivery models for significantly increasing the uptake and deployment of renewable energy across the residential, business and government sectors in the participating local government areas. The eight participating councils are Ashfield, Bankstown, Canada Bay, Canterbury, Kogarah, Leichardt, Marrickville and Rockdale. The vision of the project team is to see up to 30% of the region's energy needs being provided though renewable sources.[1]

Methodology

The *Our Energy Future* project employed a five-stage methodology to identify both enabling actions to address barriers to renewable energy uptake, and key renewable energy technology specific delivery or business models. The five-stages were:

1. Project inception and analysis of the current energy situation
2. Assessment of technical and delivery model options
3. Option prioritisation workshops with council, community and business stakeholders
4. Economic modelling of prioritised options and drafting of the *Our Energy Future: Renewable Energy Master Plan*
5. Delivery workshop and finalisation of the *Our Energy Future: Renewable Energy Master Plan*

Through this process over 160 stakeholders were engaged in the development of the *Our Energy Future* Renewable Energy Master Plan.

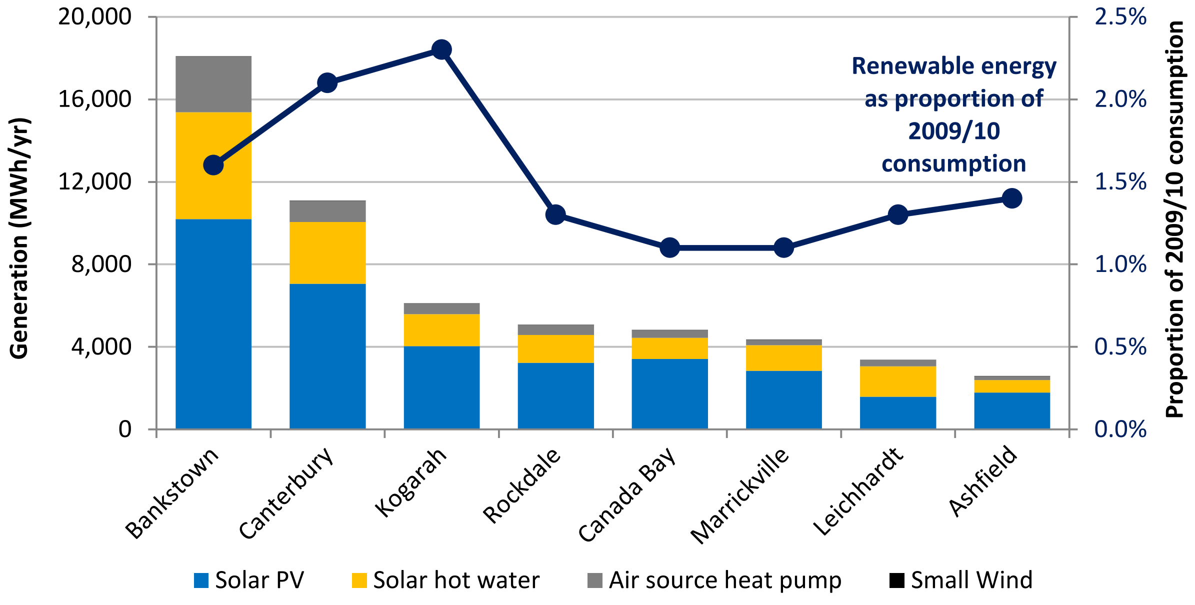
Energy Situation Analysis

Since 2009-10, electricity consumption in the SSROC region has dropped from approximately 3,600GWh to 3,370GWh in 2012-13. Local renewable energy currently accounts for between 1.1% and 2.3% of electricity demand in the participating local government areas (LGAs) (see Figure 1). The majority of these local renewable energy generators are solar PV installations (62%) totalling 34,168MWh of generation per year; solar hot water systems are the next largest renewable energy type generating the equivalent of 15,424MWh per year. Across SSROC 11% of residential dwellings have solar PV systems and 5.5% have solar hot water systems. This level of solar PV uptake compares to a NSW average of 14% and to South Australia where 30% of dwellings have solar PV systems.

This situation analysis found that SSROC has a good foundation of local renewable energy installations. The Master Plan shows that there is significant potential for more renewable energy to be generated across the region.

[1] Note, population of the whole SSROC region is 1.6 million, http://profile.id.com.au/ssroc

Figure 1: Small-scale renewable energy generation by LGA, 2010

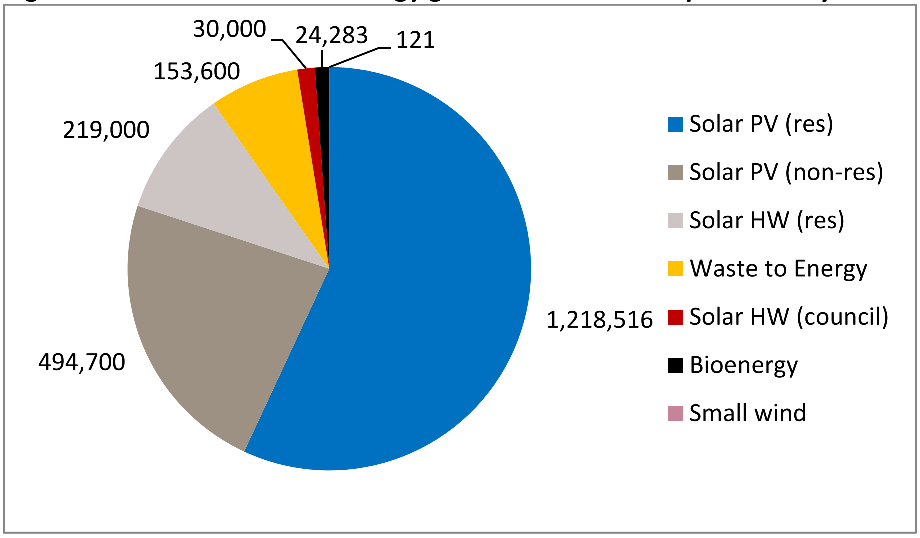


Renewable Energy Technical Potential Analysis

To calculate the renewable energy generation potential in the participating SSROC areas, ISF identified five renewable energy technologies that could be deployed in the current market environment in an urban, semi-coastal area such as southern Sydney. These technologies are:

- Solar PV
- Solar Hot Water
- Small Wind
- Bioenergy (anaerobic digestion of food waste)
- Waste to energy (advanced gasification of municipal solid waste)[2]

Figure 2: SSROC renewable energy generation technical potential by technology (MWh/a)



[2] Note that waste to energy can only be considered a partial renewable energy technology as the energy is generated from both renewable organics (food, garden waste, paper, etc.) and fossil fuel derived materials (e.g. plastics).

Methodologies were developed to model the technical potential of each of these renewable energy sources within the participating LGAs (refer to Appendix B for details). **Based on this analysis, ISF estimates that the technical potential of local, commercially viable, renewable energy generation is up to 59% of the participating councils ~3,600,000MWh (SSROC, 2012) 2011 LGA electricity demand (greatly exceeding the 30% vision for renewable energy in SSROC).**[3] **Of this, residential solar PV constitutes the greatest opportunity, followed by commercial solar PV and residential solar hot water.** Small wind represents the smallest technical potential, with only two appropriate sites identified with SSROC that could host small wind systems.

Delivery Models

Our Energy Future recognises that innovation in renewable energy is not just technical, but also institutional. As such, numerous different ways that renewable energy could be commercially deployed were identified. Fourteen renewable energy deployment models have been identified in this report, ranging from conventional models such as private residential or council ownership, to innovative new models such as leasing, community ownership and urban regional partnerships.[4] However, not every renewable energy technology can be deployed using every delivery model. Thus, the 14 delivery models of 5 technologies were combined into 36 possible renewable energy technology/delivery model combinations.

Priority Technology and Delivery Models

Through a series of stakeholder workshops, these 36 combinations were shortlisted down to eight priority options that were analysed in further detail; these options are summarised in Table 1. Of these, five options were prioritised for economic modelling. The priority renewable energy technology and specific delivery models cover those with the greatest technical potential, a diversity of technologies and delivery models, as well as options that look likely to be cost effective and socially equitable, based on a high level analysis. The selection of priority options chosen include both "quick wins" for easy deployment, as well as more ambitious and pioneering options.

Table 1: Priority renewable energy technology and delivery options

Technology/Delivery Model	Description and Council Role
1. Solar PV – business/ commercial leasing	**Description:** Businesses enter into an agreement with a solar developer to 'host' a solar PV system on their roof. The solar developer owns the solar system, and the business pays for use of the system to reduce their electricity bill. Payment can be either a predetermined amount (solar 'lease') or tied to how much solar electricity the system generates (solar 'power purchase agreement' or PPA). The business may be able to 'buy out' the system at the end of the contract. **Council Role:** Councils can help drive uptake of solar leases/PPAs

[3] Note this is technical potential not economic potential and does not take into account either the grid's capacity to except all the renewable generation or the competing roof space demand between solar hot water and solar PV.

[4] Note that while local renewable energy generation was the primary focus of the Our Energy Future Project, partnering with a regional community or council was also of interest to the project Steering Committee. This is because urban areas such as Southern Sydney are space constrained, limiting the number of feasible renewable energy technology options. However, partnering with a regional area a range of other renewable energy technology possibilities open up including large wind, concentrating solar thermal, geothermal and other bioenergy options. The technical potential of these technologies where not analysed, but they were included in the possible combination options.

	through the provision of information either themselves or through commissioning of a third party. Councils can also use a lease/PPA to install solar on their own buildings or sites (see also 7 below).
2. Solar PV – Community ownership	**Description:** A cooperative or company made up of community members invests in and owns a solar PV project that is 'hosted' by someone through a solar lease or PPA as described above. The upfront equity is recouped via payments from the host. **Council Role:** Councils can help drive community ownership by facilitating the formation of a cooperative/company in the local area, and/or by being a member of the cooperative/company and investing equity into the project.
3. Solar PV – residential leasing	**Description:** As with commercial leasing/PPAs, a residential household enters into an agreement with a solar developer to 'host' a solar PV system and use the generated electricity in return for lease payments. In NSW (and other states where only low values are available for exporting solar energy to the grid) this option is mainly beneficial for households that will utilise a large proportion of the energy generated by the system. **Council Role:** Councils can help drive the uptake of residential solar leasing/PPAs through the provision of information either themselves or through a third party. Councils could also partner with one or more pre-vetted solar developers. This should be done with care and due diligence.
4. Solar PV (and Solar Hot Water) – Council Brokering of a bulk-buy	**Description:** Councils act on behalf of the community to facilitate a bulk-purchase of Solar PV panels or hot water systems for residential and small business installation. Councils would begin with a tender process and engage a supplier to provide PV/hot water systems at a discounted rate to community members. Community members then contact the supplier directly to purchase the system at the discounted rate. This model differs from a straight bulk-buy arrangement as the Council does not actually purchase the panels, so there is no upfront financial outlay. Council could also act as a 'broker' for leasing or debt financing models for the systems. **Council Role:** To undertake a brokering arrangement, Councils could begin with a 'recruitment drive' to gain expressions of interest from households to understand the likely number and size of systems that would be purchased. Councils could then run a tender process to identify an appropriate supplier, then provide details back to the registered households as well as promoting widely through the local area. This should be done with care and due diligence.
5. Wind – Urban/regional partnership	**Description:** An urban council/group of councils and/or community group partners with a renewable energy developer to either invest in a regional renewable energy project (in the present market this would most likely be a wind farm) or enter into a power purchase agreement to source 100% renewable energy from a specific project. The project would be hosted by a regional landholder in partnership

	with the developer. **Council Role:** Broker discussions with wind-developers (and a brokering retailer if necessary) to arrange program and contract details, and promote the arrangement with council procurement policies and with businesses and community members in their local area.
6. Bioenergy – council partnership with an energy company	**Description:** This combination option would also take advantage of the collective power of SSROC and concurrently address council waste issues. It entails council developing a dedicated food waste collection service for households and/or encouraging commercial customers to divert food waste to a food waste anaerobic digestion system. While the economics of this option from a council perspective are not favourable, the technology has many wider environmental benefits. The next step should be to do lifecycle analysis and cost comparison of a range of waste management options for SSROC. **Council Role:** Develop a dedicated food waste collection system that would be diverted to a bioenergy facility owned by a renewable energy company, as well as develop and deliver community education on waste separation practices.
7. Solar PV – Council ownership	**Description:** Council ownership of solar is a key recommendation, as a council driven initiative that highlights the cost effectiveness of commercial scale solar PV. As shown in the commercial solar leasing economic analysis, as a system owner capital investment for council are high, but financial outcomes are greater as rewards are not shared with third parties. **Council Role:** Council directly install solar PV systems on their own buildings. This would be an attractive option from a local government perspective as councils typically have high and stable daytime demand in their buildings and usually own their sites, meaning they have additional security over long-term solar revenue.
8. Solar Hot Water on council and community pools	**Description:** While not economically modelled, the installation of solar hot water on council pool sites is expected to provide councils with a cost-effective opportunity to reduce direct council emissions. This opportunity is best approached from a regional perspective through a bulk tendering or purchasing arrangement to design and install solar pool heating across the range of potential pool sites considering facility upgrades. **Council Role:** Centrally coordinate a bulk tendering process for the range of council pool sites, fund, oversee installation of systems, and communicate environmental and financial benefits to the community.

Recommendations

Based on the analysis of the eight priority options and additional research into enabling actions, the following recommendations are made to progress the uptake of renewable energy in the participating SSROC council areas and beyond:

1. Continue the existing **cross-council working party** with responsibility to scope and deliver the *Our Energy Future: Renewable Energy Master Plan*.

2. Prioritise, scope, seek funding for (where required) and deliver the following **recommendations** associated with the eight priority renewable energy delivery model combinations:
    a. Install appropriately sized solar PV on all viable council roofs, potentially through a bulk tendering process
    b. Provide information and materials to facilitate commercial solar PV deployment
    c. Create a trusted list of commercial solar PV developers
    d. Develop a council residential solar PV brokering (bulk-buy) program covering both upfront purchase and leasing/PPA options
    e. Initiate discussions with wind developers and community wind projects about a wind urban-regional partnership
    f. Develop a compelling case and associated promotion materials for a council-led wind urban regional partnership
    g. Conduct a lifecycle analysis and cost comparison of waste management options including anaerobic digestion of food waste
    h. Investigate how to increase diversion of commercial food waste to anaerobic digestion
    i. Prepare a request for tender for solar hot water for community pools in the SSROC area

3. Employ the following **enabling actions** that will assist with implementing the priority renewable energy technology and delivery models:
    a. Continue with the current regional approach to renewable energy planning
    b. Provide information and resources to assist business and the community in understanding the opportunities related to renewable energy
    c. Adapt planning regulations to ensure renewable energy is facilitated and encouraged (and perhaps required) by development controls
    d. Engage with the electricity network business - Ausgrid regarding deployment promotion plans, particularly in the context of high penetrations of solar PV
    e. Lobby state and federal government for regulatory reforms, especially relating to a fair price for renewable energy export and connecting renewable energy to the electricity grid
    f. Undertake feasibility studies and demonstration projects to identify and resolve key challenges (such as grid connection, proving new business models, etc.) and demonstrate opportunities to the community
    g. Consider establishing an energy service organisation
    h. Consider establishing a revolving loan fund

4. Explore the following additional **longer-term actions**:
    a. Investigate the viability, costs and benefits of advanced gasification as both a waste and energy management option for Southern Sydney as part of the SSROC Waste Strategy
    b. Investigate niche applications of ground source heat pumps or deeper geothermal wells as part of council or large energy user renewable heating and cooling options
    c. In 3-5 years revisit the technical and commercial viability of ocean renewable energy options (wave and tidal) and energy storage

d. Once the recommendations are in train, SSROC should explore the potential to pursue other (non-prioritised) renewable energy, delivery model combinations identified in this report

The SSROC Councils, through the Our Energy Future process, have the opportunity to capitalise on a wealth of enthusiasm within their residential and business communities for new, low carbon local energy options. This Master Plan identifies a comprehensive range of priority next steps that will provide both quick wins and longer term leadership to increase renewable energy uptake in the participating council areas.

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ABBREVIATIONS AND GLOSSARY

AEMO	Australian Energy Market Operator
c/kWh	Cents per kilowatt hour – energy unit costing metric
CST	Concentrating Solar Thermal – a renewable energy technology
D-CODE	Description and Costs of Distributed Energy – ISF's distributed energy costing model
DNI	Direct Normal Insolation – a measure of the intensity of sunlight
DNSP	Distribution Network Service Provider – organisations that own and maintain the electricity grid (polls and wires)
ESCo	Energy Service Company
EUA	Environmental Upgrade Agreement
EPC	Energy Performance Contract
GWh	Gigowatt hour – a measure of energy (1 GWh=1000 MWh)
kWh	Kilowatt hour – a measure of energy
kW	Kilowatt – a measure of power
KWp	Kilowatt peak – amount of peak demand reduction potential
LCOE	Levalised Cost of Energy - indicates the cost at which each unit of electricity needs to be sold at in order for project/plant to break even
LGA	Local Government Area
MSW	Municipal Solid Waste
MWe	Megawatts electric – a measure of electrical power
MWh	Megawatt hours (1MWh = 1000kWh) – a measure of energy
MW	Megawatts – a measure of power
PPA	Power Purchase Agreement
ROI	Return on Investment
SSROC	South Sydney Regional Organisation of Councils
ToU	Time of Use – refers to a particular electricity tariff structure
Tonnes CO_2e	Tonnes of Carbon Dioxide equivalent – greenhouse gas measurement unit

1 INTRODUCTION

The *Our Energy Future: Renewable Energy Master Plan* is an initiative of eight pioneering councils in Southern Sydney – Ashfield, Bankstown, Canada Bay, Canterbury, Kogarah, Leichardt, Marrickville, and Rockdale – who recognised the important role they can play in helping their communities to transition to a renewable energy future. The aim of the *Our Energy Future* project is to identify a range of practical and cost effective actions and models for significantly increasing the uptake and deployment of renewable energy in the participating local government areas. In so doing, this project will help extend significant environmental and financial benefits to Southern Sydney Regional Organisation of Councils (SSROC) and wider communities by reducing dependence on the purchase of increasingly high cost fossil fuel generated grid electricity. Strong electricity price rises seen in recent years represent both a threat to council and community energy expenditure, and an opportunity for local renewable energy generation in the context of opening up more cost-effective opportunities to future proof against these price rises.

Our Energy Future builds upon SSROC's past and ongoing sustainable energy initiatives, including the 'Renewable Energy Scoping Study' of January 2011 and member council's participation in Cities for Climate Protection and their Energy Savings Action Plans.

The *Our Energy Future* project has identified renewable energy development activities and supporting actions that could be undertaken either independently or jointly by participating SSROC member Councils. Additionally, programs to support the wider community to increase its deployment of renewable energy have been considered. A range of possible renewable energy technologies and delivery model options are presented in this Renewable Energy Master Plan.

The role of Councils is diverse, with an array of statutory and non-statutory responsibilities. Local governments and sub-regional bodies such as SSROC are showing significant leadership in emissions reductions and renewable energy development in Australia. This is being undertaken against a backdrop of uncertainty and complexity, particularly in regards to local, state and national governance arrangements and the roles and responsibilities relating to the management of energy use. While local governments do not have statutory responsibility for supporting the communities in their area to transition to renewable energy, SSROC is taking a proactive leadership approach by seeking to better understand how to assist their Local Government Areas (LGAs) to feasibly reach ambitious carbon emission reductions, and move to a clean energy future.

1.1 STRUCTURE OF THE RENEWABLE ENERGY MASTER PLAN

The *Our Energy Future*: *Renewable Energy Master Plan* is structured in six sections:

Section 1: Introduction and project methodology summary
Section 2: Renewable Energy Technology overview and electricity generation potential
Section 3: Overview of renewable energy delivery model options
Section 4: Prioritisation of renewable energy technology and delivery model combinations
Section 5: Recommended renewable energy models and technologies to pursue
Section 6: Recommended enabling actions

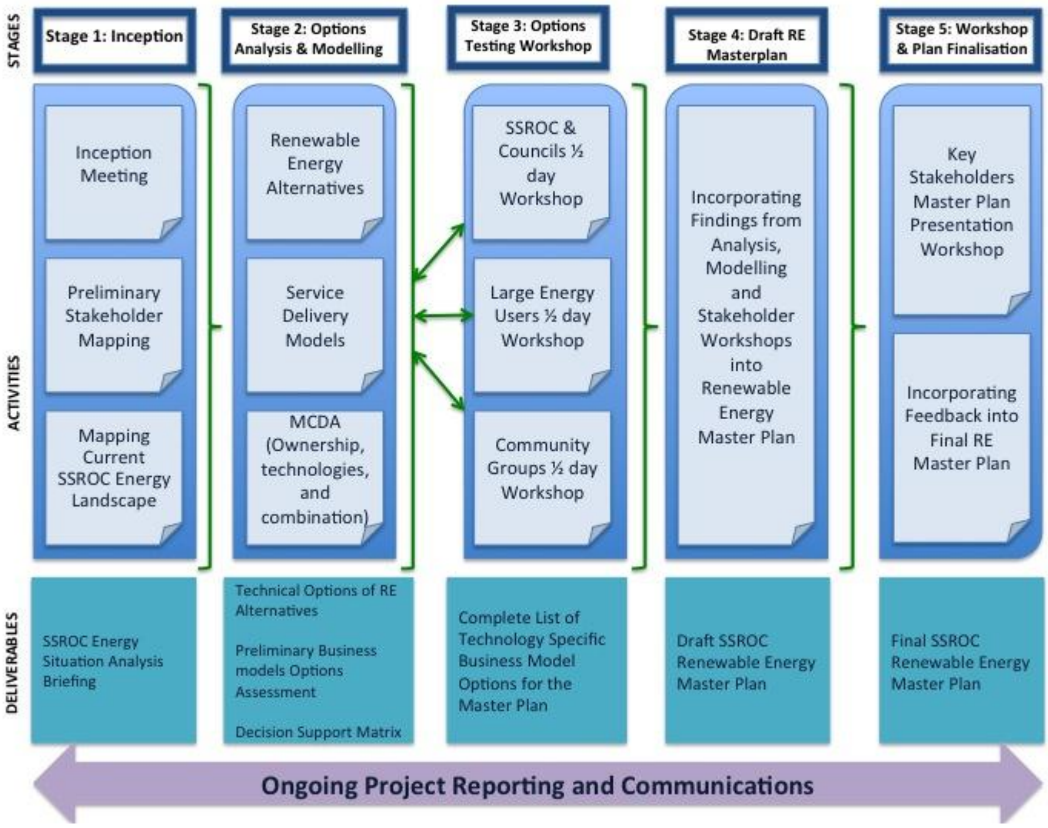
These six sections are complimented by detailed results and methodology write-ups in Appendices A-E.

1.2 METHODOLOGY

The *Our Energy Future* project was undertaken using a five stage methodology, which is outlined in Figure 3 and can be summarised as:

1. Project inception and energy situation analysis
2. Technical and delivery model options assessment
3. Options prioritising workshops with council, community and business stakeholders
4. Economic modelling of prioritised options and drafting of the *Our Energy Future* Renewable Energy Master Plan
5. Delivery workshop and *Our Energy Future* Renewable Energy Master Plan finalisation

Figure 3: *Our Energy Future* Methodology



Stage 1: Inception

The delivery of the Master Plan started with an inception workshop with political and administrative representatives from the eight participating councils, to refine the scope of, and expectations for, the *Our Energy Future* project. Additionally, key stakeholders to engage with through the project were mapped and a project Steering Committee established. Subsequently, an energy situation analysis was undertaken and provided to the Steering Committee. The energy situation analysis quantified electricity consumption and current uptake of renewable energy in the participating local government areas (LGAs), and summarised the renewable energy installations directly undertaken by the eight councils to date.

Stage 2: Options Analysis and Modelling

The second stage of the project was a high level technical and financial scoping of renewable energy options. For the financial scoping ISF drew on its Description and Cost of Decentralised Energy (D-CODE) Model to determine the most cost effective options. Councils do not have large reserves of capital and achieving high levels of renewable energy deployment within the SSROC area will require actions by multiple stakeholders. As such a range of ownership and financing models were investigated, called in this report 'delivery models'. Favourable renewable energy technology/delivery model combinations were then determined for exploration by the councils and their stakeholders

Stage 3: Options Testing Workshop
Stage 3 involved significant stakeholder engagement through three workshops – council, community and business. The workshops were attended by over 160 stakeholders. The sessions were designed to educate stakeholders, increase buy-in to the Plan, and to ensure the delivery models and technologies most likely to be successful were selected for detailed consideration. Additionally, the workshop process identified additional region specific opportunities and barriers.

To prioritise the most desirable technology/delivery model combinations, a multi criteria analysis was carried out during the workshops. A detailed overview of the prioritisation process conducted is given in Section 5 and Appendix E of this report.

Stage 4: Draft Master Plan
The top five technology/business options were then investigated further by ISF using more detailed economic modelling. This Plan also includes a discussion of barriers to specific technologies and implementation models, and a discussion of proposed solutions.

This approach is focussed on practical steps to achieve maximum deployment throughout the LGAs, at the least cost for both Councils and communities. To this end costs and benefits, including the potential for reduced energy costs for consumers, were assessed for each option, as well as the scale of energy use and carbon emission reduction.

Stage 5: Workshop and Master Plan Finalisation
The final stage of the *Our Energy Future* project involves presenting the Renewable Energy Master Plan to the project Steering Committee and helping them to develop the beginnings of an action plan to accompany the Master Plan. This process is designed to ensure that those who will have carriage of the recommendations in this Master Plan fully understand them, have identified their practical next steps and ongoing SSROC processes are set up to facilitate ongoing collaboration and implementation of the *Our Energy Future*: *Renewable Energy Master Plan*.

Box 1: Workshop Feedback
The feedback from workshop participants was overwhelmingly positive, with most business, community and council stakeholders saying they had no concerns about the *Our Energy Future: Renewable Energy Master Plan* process and were looking forward to seeing the final report. A few example comments from participants are given below:

- *Excellent coverage of the material - good opportunity to discuss the issues with others*
- *Good education of the current energy situation in Australia*
- *Valued the chance to participate.*
- *Today's workshop demonstrates the commitment of SSROC to being involved in the community*
- *The information presented was comprehensive*
- *Great to see the viable options currently being considered set out so clearly*

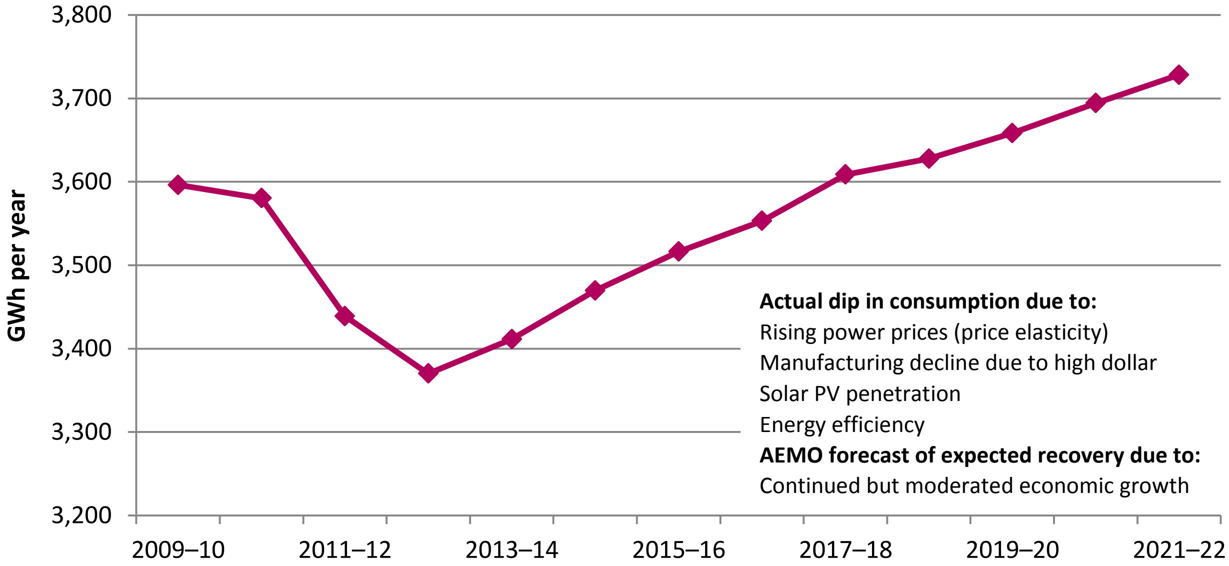
2 ENERGY SITUATION ANALYSIS

This section outlines the current and projected energy situation within the participating LGA areas. Specifically, the electricity consumption and current level of local renewable energy installed are detailed.

2.1 ELECTRICITY CONSUMPTION

Since 2009-10, electricity consumption in the SSROC region has dropped, as shown in Figure 4. However consumption is forecast to begin, and continue, to rise out to 2021.[5]

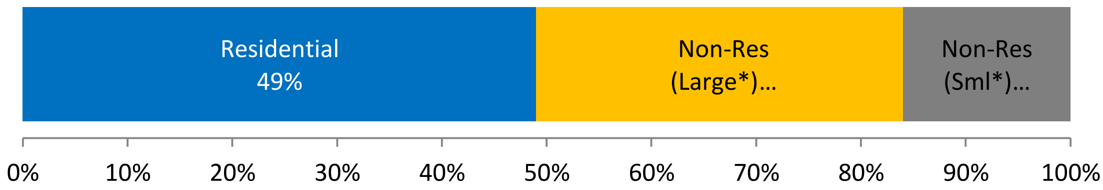
Figure 4: Past and forecast electricity consumption in the SSROC region[6]



Source: Australian Electricity Market Operator (2012) National Electricity Forecasting Report; Ausgrid supplied LGA electricity consumption data for 2009-10 base year.

Across the SSROC region, approximately half of electricity consumption comes from residential customers, as shown in Figure 5. The remaining half is split between large (35%) and small (16%) non-residential customers.

Figure 5: Proportion of total energy consumption in the SSROC region, by customer type



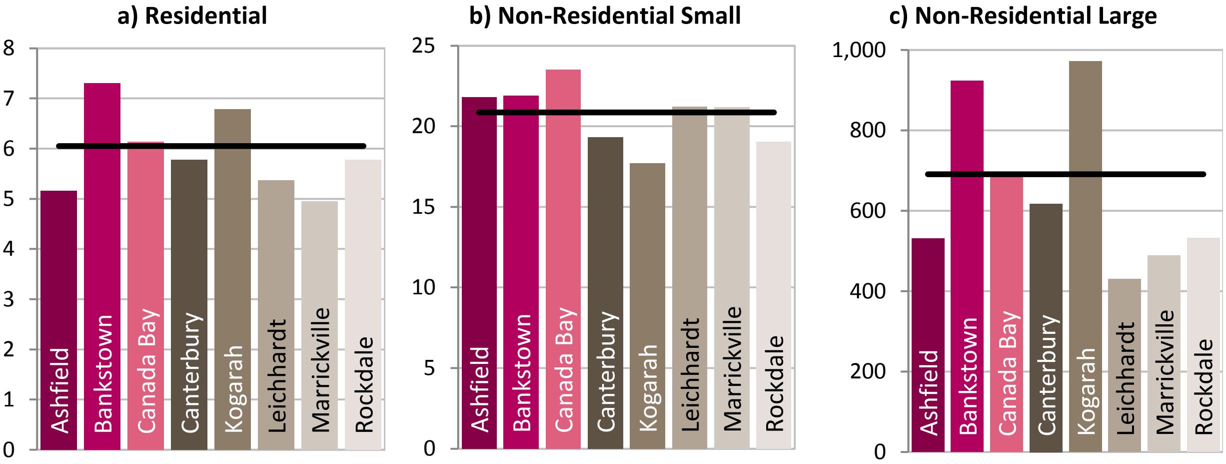
** Small: <160,000 kWh pa; Large: >160,000 kWh pa*
Source: Ausgrid supplied LGA electricity consumption data for 2009-10 base year.

[5] These numbers should be used with caution as AEMO have overestimated NSW energy consumption in recent years, and no adjustment has been made for local factors when scaling down to the LGA level. More detailed analysis is beyond the scope of this project. Note this analysis was done prior to the release of 2013 figures.

[6] Forecasts for LGAs in SSROC region are estimated using NSW wide forecast growth data from AEMO, applied to the LGA base year data 2009-10.

Figure 6 shows the average electricity consumption of each customer type for each LGA. It indicates that both inner city households and large businesses (those in Ashfield, Leichhardt and Marrickville) tend to use less electricity than those in more suburban areas such as Bankstown and Kogarah. However, Figure 6 indicates that small businesses use a similar amount of electricity across all participating LGA areas.

Figure 6: Average electricity consumption per customer (MWh/cust/yr)



Source: Ausgrid supplied LGA electricity consumption data for 2009-10.

2.2 CURRENT STATUS OF RENEWABLE ENERGY

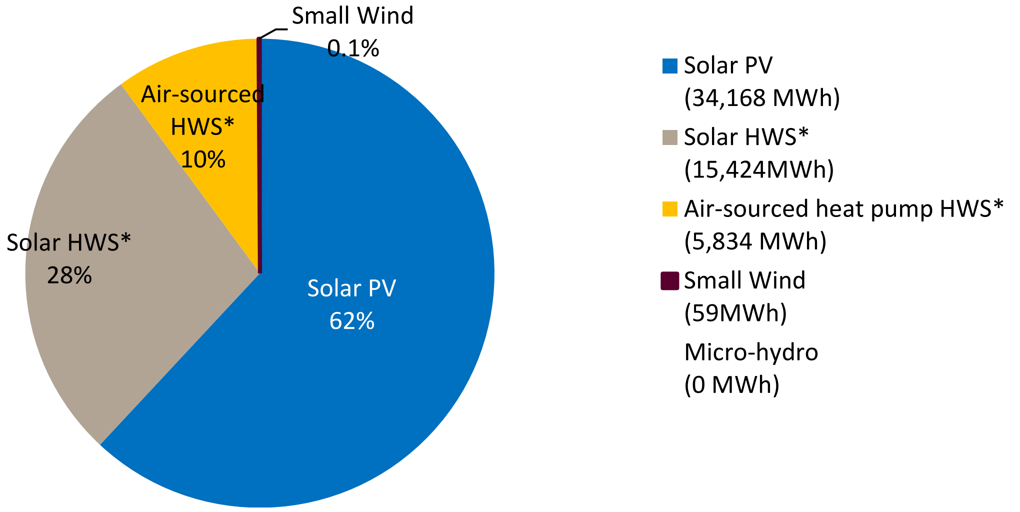
Many Southern Sydney households and businesses have already installed renewable energy systems. This section outlines the degree of renewable energy uptake to date.

2.2.1 Small scale renewable energy

Solar PV is the largest source (62%) of local renewable energy generation in the SSROC region, as shown in Figure 7. This is followed by solar hot water (28%) and air-sourced heat pump hot water (10%).[7] Small scale wind contributes only a fraction (0.1%) while no micro-hydro is reported.

[7] Air-sourced heat pump hot water systems are not technically a renewable energy option, they are an energy efficiency option. However, they are included here as they get credits from the Office of the Renewable Energy Regulator.

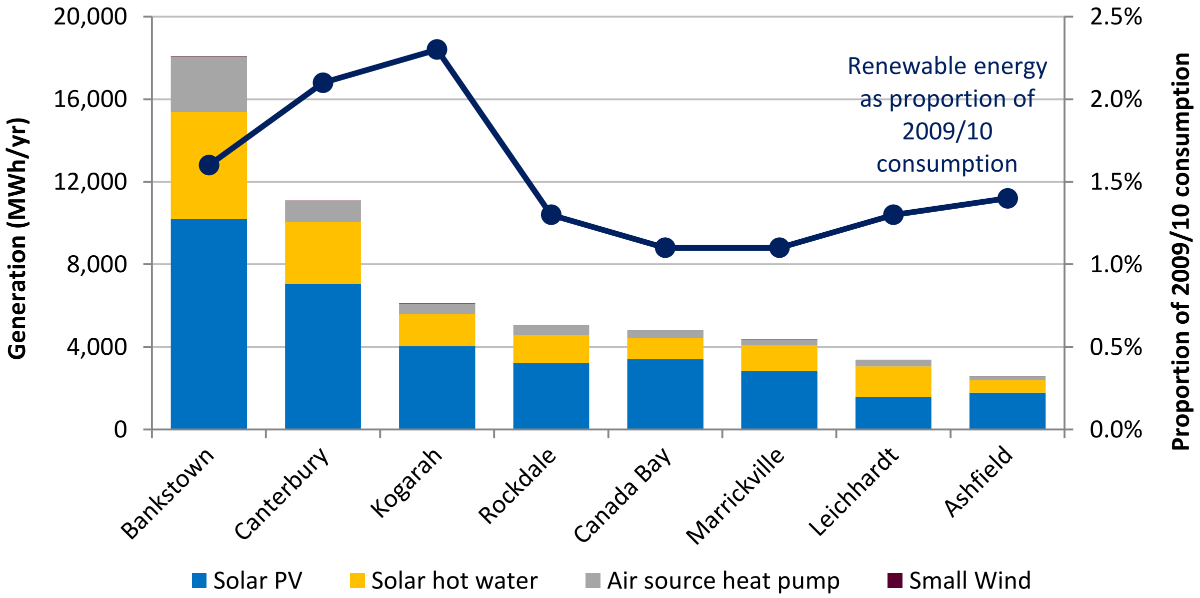
Figure 7: Annual small-scale renewable energy generation in SSROC region, by generator type[8]



**Energy saved as opposed to generated. Counted by ORER as small-scale generation.*
Source: Office of the Renewable Energy Regulator (2013), based on installed capacity as of January 2013

Figure 8 shows the small scale renewable energy generation of the LGAs in the SSROC region. Bankstown and Canterbury have the largest amount of small scale renewable energy (approx. 18,000 megawatt hours (MWh) and 11,000 MWh respectively), while Kogarah and Canterbury have the highest proportion of renewable energy relative to consumption (2.3% and 2.1% respectively).

Figure 8: Small-scale renewable energy generation by LGA

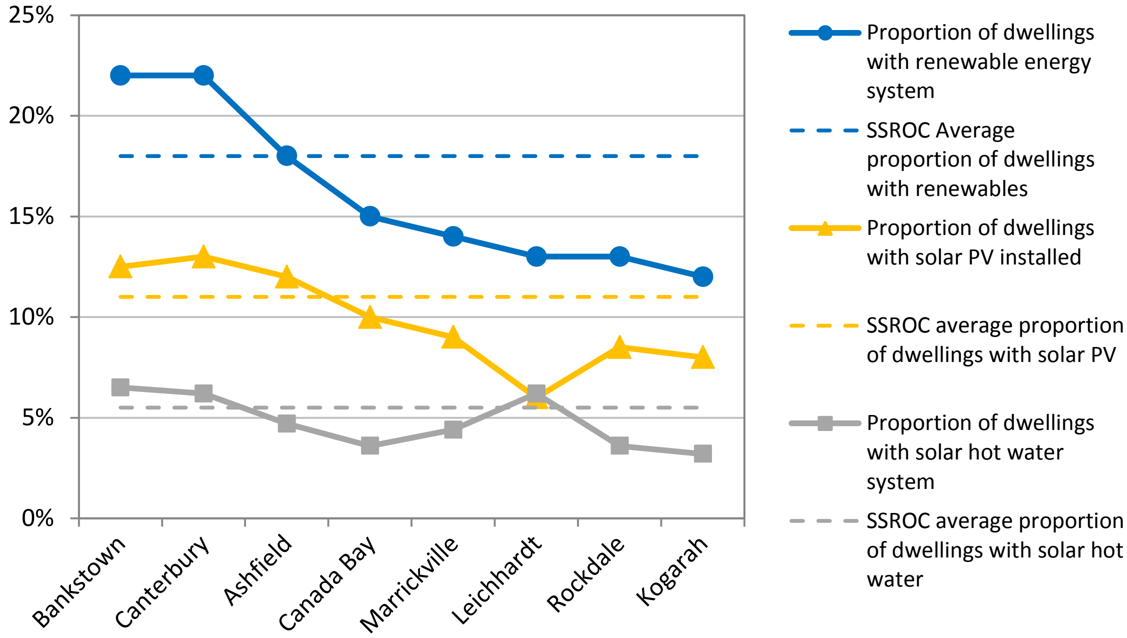


Source: Office of the Renewable Energy Regulator (2013), based on installed capacity as of January 2013; Consumption comparison data from financial year 2009/10, Ausgrid provided to SSROC

8 To calculate the figures in this pie chart, the following technical assumptions were made: 1) Capacity factor of solar PV = 14%; 2) Capacity factor of small wind generators = 12%; 3) Pre-installation hot water electricity consumption = 3000kWh/year; 4) Solar HWS and air-source heat pump HWS electricity savings relative to initial hot water electricity consumptions = 75%.

Figure 9 highlights the proportion of dwellings with renewable energy systems by LGA. It indicates that Bankstown and Canterbury have the highest proportion of households with installed systems.

Figure 9: Proportion of dwellings with renewable energy systems by LGA [9]



Source: Office of the Renewable Energy Regulator (2013); Number of Dwelling type and tenure status: ABS (2011) LGA community profiles

2.2.2 Medium scale renewable energy

In addition to household scale renewable energy, commercial or medium scale renewable energy systems are starting to be installed across the participating LGAs, particularly by Councils. Indeed, seven of the eight councils have already installed solar PV and/or solar hot water systems. Of these Bankstown and Marrickville Councils have installed the greatest capacity, at 77 and 74.5 kilowatts (kW) respectively. Table 2outlines the medium scale renewable energy systems known about in the participating LGAs.

Table 2: Council and other medium generation in the SSROC region (present and planned)

LGA	CURRENTLY INSTALLED		PROPOSED/POTENTIAL
	Council owned	Non-council	Council owned
Marrickville	Tillman Park (5kW) Deborah Little Child Care Centre (2kW) Annette Kellerman Aquatic Centre (30kW) Council Depot (30kW) Dulwich Hill Library (2kW) Chrissie Cotter Gallery (1.5kW) Solar floodlights at carparks (4kW est.) **Total installed Solar PV: 74.5kW**	ACME Case Co. (packing) (30-40kW)*	Marrickville Library upgrade (TBC)

[9] Includes only renewable energy systems registered as a Small-scale generator (including solar PV, small wind, solar hot water systems or air-sourced heat pump systems). Assumes all installations are on residential properties which are owner occupied detached or semi-detached dwellings, and that each household has only one type of renewable energy system. As a result actual numbers may be slightly lower than presented here.

Leichhardt	Leichhardt Town Hall (20kW) Administration Centre (5kW) Mort Bay Childcare (2.1kW) Blackmore Oval (9.4 kW) Lilyfield Community Centre (2.2 kW) Hannaford Centre (2.9kW) Foster Street Day Care (1.1 kW) Annandale NC (2.2 kW) **Total installed solar PV: 44.7kW**	-	Leichhardt Aquatic Centre (Up to 60kW) Balmain Library & Town Hall (3.6 kW) Balmain Depot Workshop (21.0 kW) Leichhardt Children Centre (1.0 kW)
Kogarah	Council Depot (37.8kW) South Hurstville Library (3kW) Kogarah Town Square (16 kW^) **Total Council owned PV: 56.8kW**	Kogarah Town Square (144kW^)	-
Canada Bay	Concord Community Centre* Rhodes Park Kiosk* Queen Elizabeth Park Clubhouse* Drummoyne Pool Solar Heating* Concord Library* Solar lighting in public parks – 261 lights Solar hot water at aquatic facility **Total Council owned PV: Unknown**	-	-
Canterbury	Solar PV systems on community buildings (2x3kW) Solar hot water heating at 2 aquatic centres **Total installed Solar PV: 6kW**	Barbehire Pty Ltd (10kW) Canterbury Ice Skating Rink(propose appx 100kW)	-
Bankstown	Depots, community centres and libraries (77.5kW) **Total installed Solar PV: 77.5kW**	-	-
Ashfield	Haberfield Library (10kW) **Total installed Solar PV: 10kW**	-	-
Rockdale	-	-	-

** kW size of system unknown*

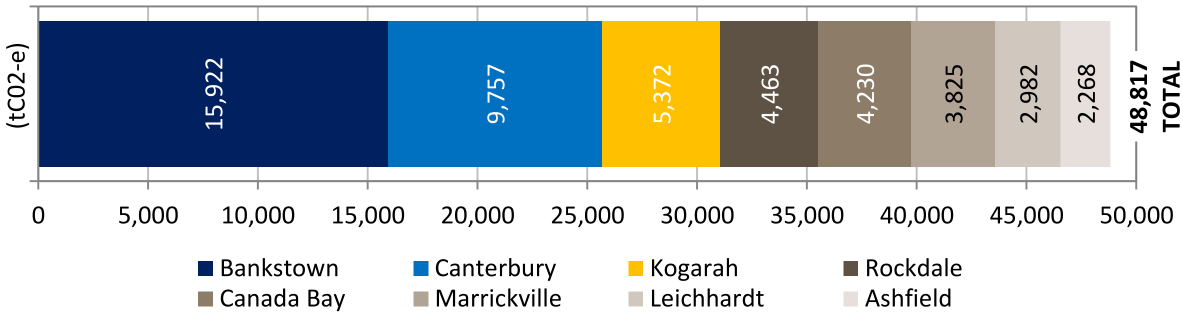
^ Ownership of this solar PV system was split between the Kogarah Town Square body corporate and Kogarah City Council

Source: Personal communication with council contacts and through SSROC project questionnaire #1

2.2.3 Emissions reduction from current installed renewable energy

Through the installation of local renewable energy systems, this area has already reduced the emissions of the participating LGAs by over 48,800 tonnes CO_2e per annum, through avoided purchase of predominantly fossil fuel generated grid electricity. Figure 10 breaks this figure down by council area.

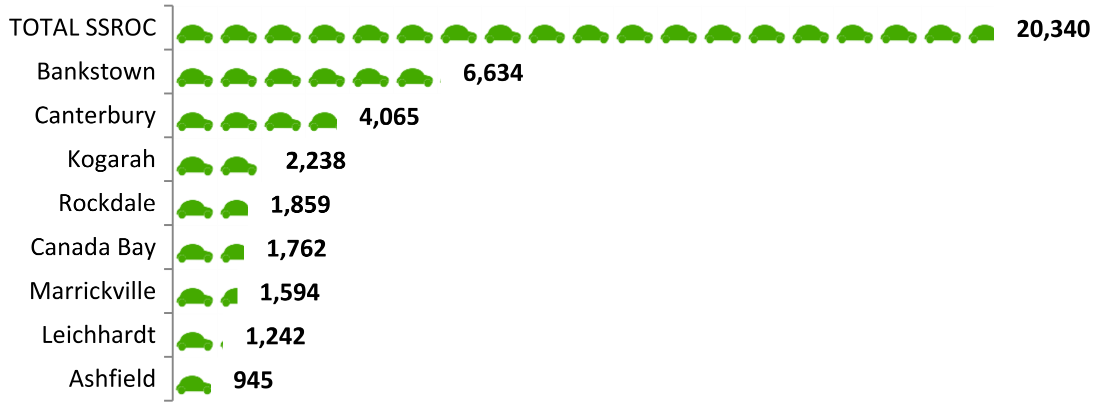
Figure 10: Annual avoided emissions reduction from small-scale renewable energy generators[10]



Source: Renewable energy systems registered as a Small-scale generator with the Office of the Renewable Energy Regulator (2013)

This reduction in greenhouse gases equates to taking approximately 20,300 cars of the road each year as shown in Figure 11.

Figure 11: Equivalent 'Cars off the road' per year from small-scale renewable energy generators[11]



Source: Renewable energy systems registered as a Small-scale generator with the Office of the Renewable Energy Regulator (2013)

This section indicates current progress towards SSROC's indicative renewable energy targets for both LGA and council. As identified above the participating SSROC community is sitting at about 2% renewable energy. The following sections outline the technical potential that could be reached and a range of initiatives that if implemented would help achieve and likely exceed the SSROC renewable energy targets of 20% for the LGAs and 30% for council operations. The renewable energy initiatives identified will not only assist with meeting SSROC's renewable energy goals but have a range of additional benefits.

10 Assumptions: 1) NSW grid emissions factor 2011-12 = 0.88; 2) Capacity factor of solar PV = 14%; 3) Capacity factor of small wind generators = 12%; 4) Pre-installation hot water electricity consumption = 3000kWh/year; 5) Solar HWS and air-source heat pump HWS electricity savings relative to initial hot water electricity consumptions = 75%

11 Assumptions: As per Figure 10, and each car emits 200g/km and travels 12,000km/year.

3 ANALYSIS OF RENEWABLE ENERGY POTENTIAL

The following section provides an overview of the renewable energy technologies that are considered in this Master Plan.

In this project, ISF has identified six renewable energy technologies that could be deployed in the Southern Sydney area – solar PV, solar hot water, bioenergy, waste to energy and geothermal (heat pumps). These technologies are described in detail in Section 3.1. Of these the technical electricity generating (or avoidance) potential has been modelled, for five of the six options. The capacity of ground source heat pumps in the Southern Sydney area has not been calculated due to their highly site specific nature and niche applications. ISF has also identified renewable energy technologies that could be deployed in a regional area that communities or councils in Southern Sydney could partner with (see Urban/Regional Partnerships delivery model in Section 4). Due to the unbounded nature of these regional renewable energy options, the technical potential has not been modelled; however the technologies are described in Section 3.2. A list of technologies not considered in this Renewable Energy Master Plan and associated rationale is provided in Section 3.3.

Section 3.4 provides a summary of the technical renewable energy generating capacity in Southern Sydney, while Section 3.5 gives a high level economic analysis of these five main options. Expanded analysis of the energy generation potential of each modelled renewable energy option is given in Appendix B along with the associated calculation methodology.

3.1 RENEWABLE ENERGY TECHNOLOGIES SUITABLE FOR SOUTHERN SYDNEY

3.1.1 Solar PV

Converts sunlight to electricity

Electricity Generating Potential: 1,855 GWh/yr
Residential: 1,360 GWh/yr
34% of SSROC 2009/10 elec. demand
Commercial & Industrial: 495 GWh/yr
14% of SSROC 2009/10 elec. demand

Emissions reduction: 1,628 ktCO_2e/yr
Residential: 1,196 ktCO_2e/yr
Commercial & Industrial: 432 ktCO_2e/yr

Site required:
Ideally shade free, north facing site. Ideal for rooftop generation. Typically requires regular daytime building electricity use on site to be economically viable.

Challenges:
The penetration of solar PV modelled while technically possible from a space availability perspective, would far exceed the capacity of the current electricity network to take this level of generation. Some buildings are not suitable for solar PV either physically or due to the split incentives of a landlord tenant relationship, thus creating haves and have nots unless alternative models are developed.

Opportunities:
Solar PV on residential and commercial roofs represents the biggest single renewable energy opportunity in the South Sydney area. Solar PV is viable on a significant proportion of the buildings in southern Sydney, and as such is appropriate for many residential, and commercial customers. Therefore both residential and commercial models are considered in this plan.

3.1.2 Solar Hot Water

Converts sunlight to heat

Electricity Generating Potential: 216 GWh/yr
Residential: 216 GWh/yr,
6% of SSROC 2009/10 elec. demand
Public Pools: 30 GWh/yr
1% of SSROC 2009/10 elec. demand

Emissions reduction: 193 ktCO_2e/yr
Residential: 193 ktCO2e/yr
Public Pools: 26 ktCO2e/yr

Site required:
Ideally shade free, north facing site. Ideal for rooftops.

Opportunities:
Viable with appropriate site for residential, and many commercial customers.

3.1.3 Bioenergy – Anaerobic Digestion of Food Waste

Converts food waste to energy through an anaerobic composting process.

Electricity Generating Potential: 24 GWh/yr
Residential: 10 GWh/yr
Commercial & Industrial: 14 GWh/yr
0.7% of SSROC 2009/10 elec. demand

Emissions reduction: 21.4 KtCO_2e/yr
Residential: 8.9 KtCO2e/yr
Commercial & Industrial: 12.5 KtCO2e/yr

Resource required:
Requires significant separated food waste resources with no significant alternative use.

Challenges:
Generator must be significant scale. Requires efficient fuel supply chain i.e. collection, transport and sorting of waste. To create this food waste supply chain particularly at a residential level, will be costly, complex and require significant public education. Thermal conversion process generates localised emissions such as particulates.

Opportunities:
Already there is an operating food waste anaerobic digestion facility in Sydney that has not reached its full capacity. As such, increased amounts of bioenergy could be developed in the Sydney area without the need for substantial capital outlay. Viability is improved if waste heat is used for useful purpose via cogeneration or trigeneration (i.e. industrial processes, heating). Anaerobic digestion of food waste is a combined bioenergy and waste recycling solution.

Note: Residential scale bioenergy systems were not included as the technology is not in operation in Australia, and technology transfer to Australian context is difficult.

3.1.4 Waste to Energy – Advanced Gasification

Municipal solid waste is gasified in a high temperature environment creating a syngas that can be used to generate heat and electricity.

Electricity Generating Potential: 153 GWh/yr
4% of SSROC 2009/10 elec. demand

Emissions reduction: Not calculated[12]

Site and resource required:
Requires sufficient land in an industrial zoned area. The municipal solid waste (MSW) resource should be the residual materials going to landfill i.e. not including recyclables or hazardous waste.

Challenges:
Advanced gasification while used extensively in other parts of the world, is a new technology in Australia. As such there will be many learning/pioneering challenges associated with developing the first plant. Advanced gasification can be considered a partial renewable energy technology; energy generated from the biological organic fraction of the waste (food, leather, green waste etc.) can be considered renewable, while the energy generated from fossil fuel based organics such as plastics, cannot be considered renewable energy. Advanced gasification would produce airborne emissions such as particulates and must be carefully regulated. Waste to energy technologies if not positioned in a comprehensive waste strategy can perpetuate the generation of waste and prevent effective waste minimisation strategies.

Opportunities:
Waste to energy through advanced gasification is a relatively straightforward waste management strategy, as it does not require new source separation or collection infrastructure and generates energy much more efficiently than landfill. There is also significant energy generating potential and potential alignment with the new regional waste and resource recovery plan currently under development by the SSROC Councils.

[12] Greenhouse gas emission reduction potential was not calculated as this requires estimating the proportion of the waste stream that comes from biomass material versus fossil-fuel derived or inert material and the associated emission factors. This calculation process was beyond the scope of this project.

3.1.5 Wind

Converts wind to electricity

Electricity Generating Potential: 0.1 GWh/yr
0.003% of SSROC 2009/10 elec. demand

Emissions reduction: 0.1 ktCO2e/yr

Site required:
Requires a windy and non-turbulent site, which particularly in urban environments means a turbine with significant height to avoid urban turbulence.

Challenges:
It is very difficult to find appropriate sites in urban areas, as any obstacles such as buildings or trees create turbulence. Thus, wind turbines to be technically and economically viable, need to be at least 10m taller than any obstacles in a 100m radius. This can be challenging within current urban planning laws. Additionally, the Sydney basin has low average wind speeds. Thus only two potentially viable sites for wind were located in the participating SSROC council areas - Carss Park Olympic Pool in Kogarah and Dolls Point in Rockdale

Opportunities:
Can be viable with appropriate site and appropriate load offset. Additionally, they provide an iconic example of local renewable energy generation.

Note: Roof-mounted wind systems were not included as they are not economically sound due to slow wind speeds and turbulence in urban areas. Utility scale-wind energy are also not included as they are not appropriate in urban areas, however a viable option for SSROC to utilise this technology is to explore a partnership with a rural council or community for a joint investment in a large-scale utility wind system. This is a delivery model (with technically unlimited potential) and therefore this is discussed in more detail in Section 4.

3.1.6 Ground Source Heat Pumps

Sources heat from the ground to heat buildings or feed into trigeneration.

Electricity Generating Potential: n/a
Emissions reduction: n/a
How it works:
Ground source heat pumps recover low-temperature geothermal energy from shallow ground – typically tens of metres. Heat pumps then multiply the recovered thermal energy. These heat pumps are usually connected to the grid, and so are only partially renewable technologies unless connected the pump is run from a renewable electricity generator. Ground source heat pumps could be used for residential and small commercial buildings.

Challenges:
Grid electricity is still required to operate ground source heat pumps, as such to make them a fully renewable option they should be run from a renewable electricity generator. They are rare in Australia and as such can be expensive. As with many renewable energy technologies, it is important to appropriately size ground source heat pumps to the building's energy needs.

Opportunities:
Note while ground source heat pumps could work in Southern Sydney, its technical potential is not modelled due to complexity and likely niche application. Nevertheless, if these options are of interest, developing one or more pilot projects and undertaking associated feasibility studies for specific locations would be the appropriate next steps.

3.2 RENEWABLE ENERGY TECHNOLOGIES SUITABLE FOR REGIONAL PARTNERSHIPS

There are four main renewable energy technologies that could be appropriate for the SSROC councils or wider community to pursue with a partner (perhaps a council or regional alliance of councils) in regional NSW (or another state)– wind, concentrating solar thermal, bioenergy and solar PV. These technologies can be deployed on a medium to utility (large) scale and are commercialised or in the early commercialisation phase in Australia and/or internationally.

Wind

Converts wind to electricity
Large wind turbines are a larger version of the small wind technology that could be deployed at two sites in SSROC, as per Section 0 above. Typically, wind projects use >2MW wind turbines, in farms ranging from two to 100s of wind turbines.

Concentrated solar thermal

Converts a large area of sunlight, concentrated by mirrors to a specific point, to electricity via heat
Concentrating solar thermal (CST) is not appropriate for urban and coastal areas and therefore a technical potential was not conducted for SSROC. CST requires a high value of direct normal irradiance (DNI) to be economically viable. Extended periods of indirect sunlight (cloud coverage and haze), similar to common conditions in the Sydney region, prevent a CST system from operating as designed. Within SSROC, the cloud cover and haze are too high to make CST economically viable. However, similar to utility-scale wind, this technology could be developed in partnership with a rural community or council and therefore is included in the delivery options analysis below.

Bioenergy

Converts biomass into electricity and/or heat
There are a large range of bioenergy technologies. They convert biomass feedstocks through a range of processes into useful energy (for example, heat, electricity, transport). Key feedstocks include agricultural wastes, green waste, food waste, coppicing or sustainable dedicated energy crops. Example bioenergy conversion processes include anaerobic digestion, pyrolysis, advanced gasification and direct combustion. In a regional partnership there are many more possible bioenergy feedstocks than in an urban area, and thus greater variety of bioenergy projects and greater economies of scale are likely to be possible.

Solar PV

Converts sunlight to electricity
Solar PV as per the technology description in Section 3.1.1, however in a regional partnership, solar PV could be undertaken at a larger scale, including large ground-mounted solar farms.

3.3 RENEWABLE ENERGY TECHNOLOGIES NOT CONSIDERED

Five possible renewable energy technologies were not considered in this Master Plan – micro-hydro, off-shore wind, ocean energy, hot rock geothermal and geothermal wells. A short description and rationale for not including these technologies are given below.

Microhydro

Falling water spins a turbine to generate electricity

No possible sites were identified within the Council catchment areas.

Ocean – Wave and tidal

Captures the energy of ocean waves (driven by wind) and tides (driven by gravity)

Technology is still in research and development phase and is not commercially viable. The focus of this Master Plan was on actions to be undertaken in the short- to medium-term, however in the long-term, there may be sites, particularly for wave power, adjacent to the SSROC region. SSROC should re-evaluate the status of this technology in three to five years' time.

Offshore wind

Turbines placed in bodies of water to convert offshore winds to energy

The technology is more expensive than conventional wind and there is currently no industry experience in Australia. However in the long-term, there may be offshore sites available near the SSROC region.

Hot Rock Geothermal

Converts the earth's heat at depth to electricity

While geothermal plants are operational in areas of significant geothermal activity (e.g. New Zealand, Iceland etc.), the Hot Rock geothermal technology that would harness the significant hot rock resource in central Australia, is currently still in the research and development or pre-commercialisation phase and as such has not been considered in this report, even as a regional partnership option.

Geothermal Wells

Converts the earth's heat at depth to hot water for heating and cooling

Geothermal wells are typically drilled much deeper than ground source heat pumps described in Section 3.1.6, usually to a depth of several hundred metres (though less than 1km). At this depth, subsurface temperatures are generally sufficient to heat water to a temperature suitable for injection into a thermal energy network that may, for example, be supplied by trigeneration. Heated water from geothermal wells is most commonly used for commercial and industrial heating and cooling. They were not considered in this report as their application was considered niche and unlikely in the Sydney climate.

3.4 SUMMARY MATRIX OF TECHNICAL ANALYSIS

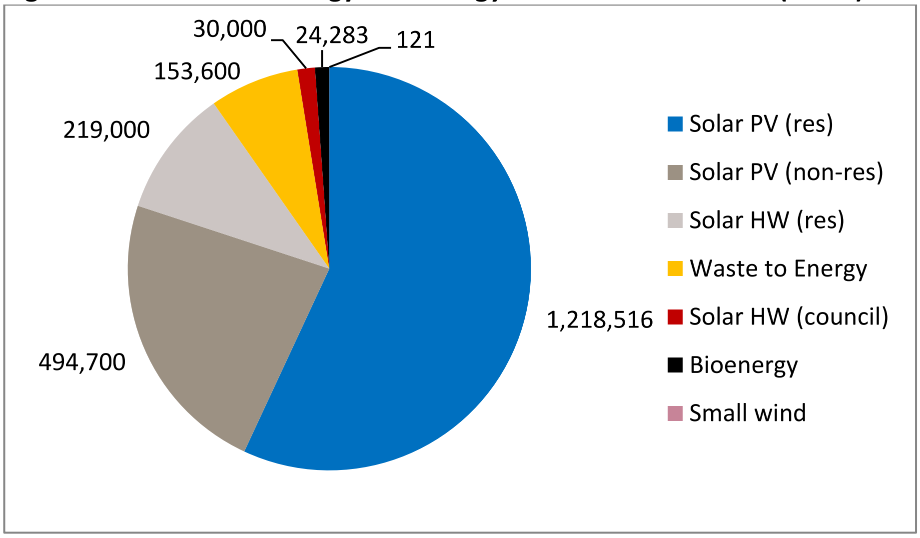
The technical potential in SSROC of five viable renewable energy technologies is summarised in Table 3. The table separates the technical capacity of both solar hot water and solar PV by residential and non-residential (commercial and council) applications. The methodologies for these estimations are described in Appendix B. **Error! Reference source not found.** indicates that residential solar PV has the most energy generation potential of all the renewable energy options analysed, while small wind has the potential to contribute the least energy and at the highest levelised cost of energy.

Table 3: Summary of technical analysis of seven technologies

Technology Option	MW Potential	Up-front installed cost ($/W)	Levelised Cost of Energy [13](c/kWh)	Annual Energy Production (MWh/yr)	Annual GHG Reduction ($ktCO_2e/yr$)	Summer Peak demand reduction (kWp)
Solar PV [Residential]	1,100	$2.4	20.5-29.8	1,218,516	1196	310,800
Solar PV [Non-residential]	350	$2.2	19.1	494,700	432	98,000
Solar Hot Water [Community Pools]*	N/A[14]	N/A	N/A	30,500	26	N/A
Solar Hot Water [Residential]	25	$17.5	22.0	219,000	193	2,500
Bioenergy (anaerobic digestion)	6.6	$14.0	-6.3	20,877	18.37	6,289
Waste to Energy (advanced gasification)	21.9	$5.2	4.9	153,500	Not calculated	20,800
Small Wind	0.11	$10.0	113.6	121	0.1	11
Total	**1,504**			**2,137,214**	**1,865**	**438,400**

** As limited data was available within the scope of this project to ground-truth modelled results, insufficient certainty was able to be obtained in order to estimate these figures in electrical equivalent terms.*

Figure 12: Renewable Energy Technology Generation Potential (MWh)



The total energy consumption of the LGAs of all participating SSROC Councils in 2009/10 was ~3,600,000MWh (SSROC, 2012) and the technical potential of renewable energy generation calculated here equates to approximately 59% of this total energy demand.

[13] Levalised cost of energy (LCOE) is a metric in energy economics that indicates the cost at which each unit of electricity needs to be sold at in order to break even. It combines at all the costs over the lifetime of a project/technology.

[14] This calculation was not performed, as the pool heating being replaced would be a mix of gas and electrical, and a more detailed site-specific analysis would be required to obtain a meaningful answer.

Caveats on this analysis
It should be noted however, that this is approximate feasible *technical* potential and not economically viable potential ('*economic* potential') of renewable energy supply in the participating council areas. Further, this is an ultimate projection and does not take into account an energy demand forecast for the participating areas (i.e. this potential is compared to 2009/10 energy demand data not 2030 energy demand forecast). Finally, the residential solar hot water and solar PV options both require roof space; this competing demand for roof space has not been accounted for in the technical potential calculations. As such it is somewhat misleading to sum the potentials of these options together.

3.5 TECHNOLOGY COSTING ANALYSIS

A high level costing analysis has been undertaken of these seven renewable energy options, using ISF's Description and Cost of Decentralised Energy (D-CODE) Model. D-CODE generates cost curves (Figure 13) comparing the levelised cost of energy (LCOE)[15] (height) and the generation potential (width) of each technology option. The red dotted line on Figure 13 indicates the current NSW regulated retail price for small business and households, while the orange dotted line indicates the wholesale or energy price component of a standard electricity bill or the price an embedded generator is likely to receive if it exports electricity to the grid.

The option furthermost left on the cost curve, food waste anaerobic digestion, has a negative LCOE due to the income stream available from waste avoidance. This means that with the assumptions and data used by ISF, regardless of the price at which the electricity is sold, a profit will be made by the generator. However, these figures are from the perspective of the generator, they do not take into account the cost of collection and wider societal costs. These are explored in more detail in Section 6.4 and indicate the economics of food waste bioenergy are significantly less favourable than Figure 13 suggests.

The majority of the potential energy generation is through solar PV and solar hot water options. For these options to be economically viable they would need to offset a grid electricity price (or be paid) a minimum of:

- 19c/kWh for commercial solar PV,
- 22c/kWh for optimal residential, and
- 30c/kWh for sub-optimal residential solar PV.[16]

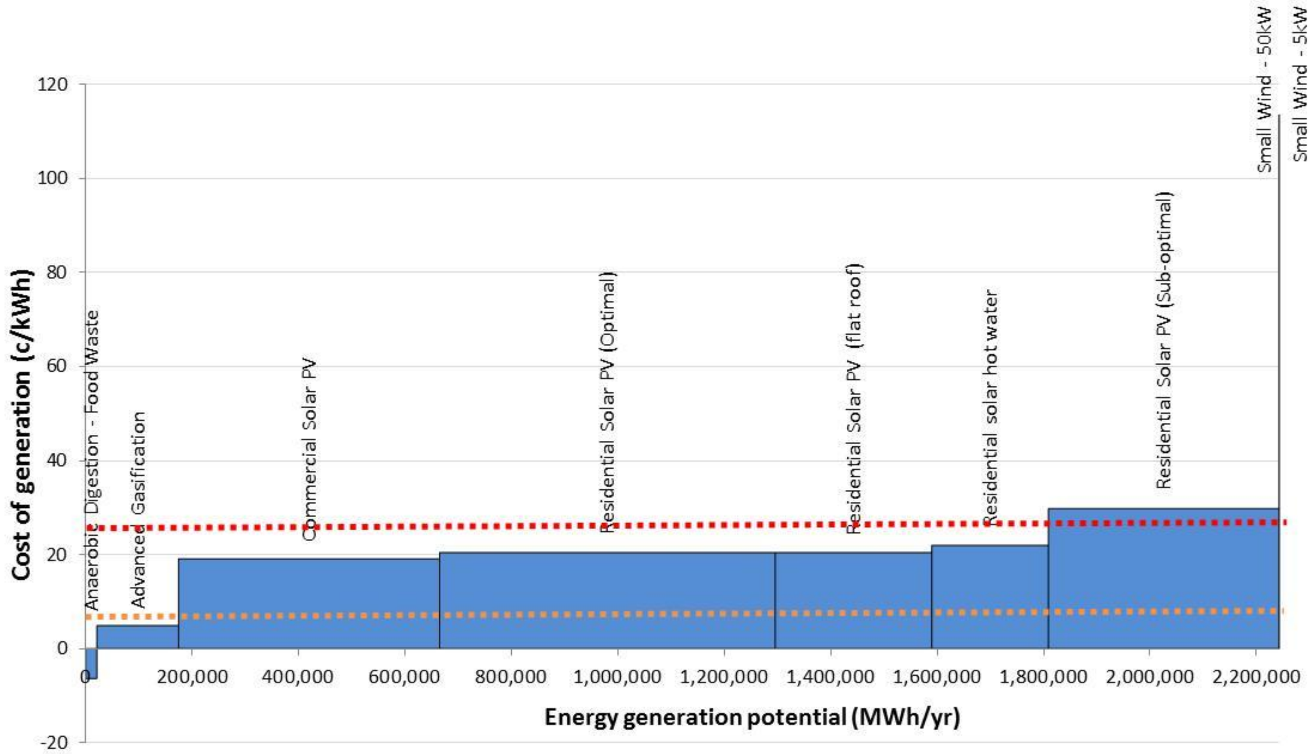
If these amounts are compared to retail electricity prices (~27c/kWh for residential and small business customers), it indicates that commercial solar PV is likely to be cost effective, however sub-optimal residential solar PV (partially shaded PV, or PV on east or west facing roofs) is likely to cost marginally more than grid electricity over its lifetime than grid electricity.

The final two options are small wind options, which contribute a significantly smaller energy generation potential than the other options shown and at a much higher cost, substantially more than the retail cost of grid electricity. These options are furthest to the right on the cost curve and are almost impossible to see due to the small amount of potential.

[15] Levalised cost of energy (LCOE) is a metric in energy economics that indicates the cost at which each unit of electricity needs to be sold at in order to break even. It combines at all the costs over the lifetime of a project/technology.

[16] Note these figures do not take into account any additional income streams such as renewable energy certificates (RECs).

Figure 13: Cost curve for renewable energy technologies in SSROC region



Key:
Dotted orange line - average NSW wholesale electricity price (IPART, 2013)
Dotted red line – approximate residential and small business retail electricity price, 2012/13 (IPART, 2013)

4 DELIVERY MODELS

Historically, energy assets have almost entirely been owned and financed by large private companies or governments. However, increasingly renewable energy generators are being owned and financed by a range of new actors from households, to dedicated community renewable energy organisations, energy service companies and more. Indeed, one of the biggest areas of innovation in energy is no longer the technology, but the business and delivery models. Delivery model is a term used to describe organisational or business models that deploy renewable energy with different owners, renewable energy asset hosts, financers and project developers.

Through the *Our Energy Future* project, ISF has identified 14 archetypal renewable energy delivery models:

1. Private ownership (residential)
2. Private ownership (business)
3. Private (developer)
4. Council ownership
5. Bulk buy/brokering
6. Community ownership
7. Energy performance contract
8. Environmental Upgrade Agreement
9. Donation based fundraising
10. Leasing
11. Council partnership with energy company
12. Developer & community partnership
13. Urban/regional partnerships
14. Crowd-funding (investment)

A brief synopsis of the 14 delivery models are provided below, with full explanations including examples available in Appendix D. In addition to the 14 delivery models, combination or hybrids are possible. As such, it should be noted that, within each delivery model, there are a range of nuanced options. Indeed the more detailed the investigation of renewable energy delivery models, the more hybrids and versions emerge. This classification of 14 models highlights the main options that have been widely publicised; however, not all of them are viable in Australia at the time of writing.

Private Ownership (residential)

Private households install renewable energy directly on their property. The household can use the power they produce and/or export the power to the grid and receive a feed-in tariff (if one is available). Some banks, financial institutions, and local councils provide schemes to encourage the uptake of renewable energy.

Private Ownership (business)

This is a standard business model where a private company that is a large energy user in the region purchases and owns a renewable energy system, generally to use the electricity onsite.

Private (developer)

The standard business model where a renewable energy developer either develops and owns a renewable energy project or develops and sells a renewable energy project.

Council ownership

Council purchases renewable energy infrastructure, most commonly to power council facilities.

Bulk buy/brokering

A bulk buy or brokering arrangement is where a facilitating organisation (such as a council) gathers many buyers of the same type of product to aggregate buying power and thus receive a lower price. This can be applied for renewable energy systems that are commonly installed such as solar PV and solar hot water systems. The facilitator may select a supplier and/or installer through either a tender process with the final system prices being determined by acceptance of a tender application, negotiation, or via a reverse auction. Alternatively, the facilitator may select a subset of suppliers/installers offers and allow the buyer to make the final decision on which supplier/installer to go with.

Community ownership

A community ownership arrangement refers to a renewable energy infrastructure project developed and owned by community members. Typically this is done by establishing a special purpose organisation such a cooperative or company that community members invest in directly.

Energy performance contract

Energy performance contracts are a method of financing upgrades to energy systems. An energy performance contract is signed between the customer (a public or private organisation) and the energy service company (ESCO). This contract stipulates a guaranteed level of energy savings that the organisation will receive and a management fee that will be paid to the ESCO. The ESCO is responsible for the implementation and maintenance of the energy savings program and the management fee is not paid if the guaranteed savings are not achieved. In this way the technical and, in some cases, financial risks of energy savings programs are transferred from the customer to the ESCO. Energy performance contracts (EPCs) are most commonly used for energy efficiency upgrades but can also be used for the implementation of renewable energy infrastructure.

Environmental Upgrade Agreement

Environmental Upgrade Agreements (EUAs) involve Council entering into an agreement with a commercial building owner and finance institution. The agreement has three components:

1. Financial institution advances funds to building owner for environmental retrofitting works.
2. Council levies an “environmental upgrade charge” on the building through rates collection.
3. Council uses the charge to repay the loan from the financial institution.

The charge will remain on the rateable land until the funds advanced by the financier are repaid in full. Where agreement is made with tenants’ consent, the property owners can pass part of the environmental upgrade charge to the building occupiers (tenants). Environmental Upgrade Agreements are most commonly used for energy efficiency upgrades but can also be used for the implementation of renewable energy infrastructure.

Donation based fundraising

This refers to renewable energy infrastructure that is funded through donations. This may be facilitated using traditional charitable fundraising methods such as events, raffles etc or through a crowd funding platform (online fund-raising for a specific objective) to generate initial funding. The reliance on donations to raise capital means that this model is most likely to be used for adding renewable energy to community assets (school, sports club, community hall, church etc) to lower power bills rather than building large renewable energy systems.

Leasing

This refers to a situation where a lessor owns and installs a renewable energy system on the roof of an electricity user. The electricity user, or host, agrees pay for the use of the system through a regular payment in return for being able to use the electricity and thus benefit through electricity bill reduction. This delivery model is only currently available for solar PV. This payment to the lessor may be in the form of a regular predetermined amount (regular lease payment) or tied to how much PV electricity the host actually consumes ('behind-the-meter'), whereby the payments are made through private billing based on a predetermined electricity price (known as a power purchase agreement (PPA)).

Council partnership with energy company

A council chooses an energy development or services company to act as their partner in renewable energy project development, operation and/or financing.

Developer & Community partnership

A renewable energy developer partners with a community group to develop, own and finance a renewable energy asset/project.

Urban/Regional Partnerships

Urban/Regional partnership is the idea that councils or communities in an urban area like southern Sydney could partner with councils or communities in a regional area that has a good renewable energy resource. There are many possible variations of how a rural/urban partnership might work and it is likely that this model could contain elements of the other models presented here.

Crowd-funding (investment)

This model relies on crowd funding to attract equity investment in a renewable energy project/asset. Crowd funding is typically a donation-based funding model, however, increasingly dedicated international crowd funding platforms are being used to attract investment in social enterprises such as renewable energy projects. In Australia, the legal status of investment based crowd funding is still unclear.

In each delivery model the benefits of renewable electricity and financial return are shared differently with different actors. Table 4 describes how these likely financial benefits are split between households, businesses, renewable energy developers/companies, community organisations and council. The delivery model options are grouped according to council's role in the delivery model, specifically as an owner, a facilitator or a mixed role.

Table 4: Potential financial benefits of delivery models to different stakeholders

Delivery Model	Residential		Business		Council		Community Org		RE Developer
	Reduced Bills	Dividend	Reduced Bills	Dividend	Reduced Bills	Dividend	Reduced Bills	Dividend	Dividend/ Ongoing Service Payment
Council as owners									
Council ownership					✓				
Council partnership with energy company					✓	✓			✓
Council as facilitators									
Bulk buy	✓		✓	✓			✓		
Donation fundraising							✓		
Private (residential)	✓								
Private (business)			✓						
Private (developer)									✓
Council as facilitator or participant									
Community ownership		✓	✓	✓	✓	✓		✓	
Leasing	✓		✓		✓		✓		✓
Urban/regional partnership		✓		✓		✓		✓	
Developer & Community partnership		✓		✓		✓		✓	✓
Crowd-funding (investment)		✓	✓	✓	✓	✓		✓	✓
Energy performance contract			✓		✓				✓
Environmental Upgrade Agreement			✓						✓

5 PRIORITISING RENEWABLE ENERGY TECHNOLOGY/DELIVERY MODEL COMBINATIONS

When the 14 delivery models are coupled appropriately with the 9 different renewable energy technologies considered in this Renewable Energy Master Plan, 36 possible combinations (called in this report 'combination options') are identified.[17] The 36 combination options are summarised in Table 5.

Table 5: Partnering of renewable energy technologies and delivery models

	Bulk buy/Brokering	Community ownership	Council ownership	Council partnership with Energy company	Crowd-funding (investment)	Donation based fundraising	Developer & Community partnership	Energy performance contract	Environmental Upgrade Agreements*	Leasing	Private (business)	Private (developer)	Private (residential)	Urban/Regional Partnership
Solar PV	✓	✓	✓	✓	P	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solar Hot Water	✓		✓			✓		✓	✓		✓		✓	
Bioenergy		✓	✓	✓			P					✓		✓
Waste to Energy			✓	✓								✓		
Small wind			✓			✓					✓	✓		
Large Wind														✓
Concentrating Solar Thermal														✓

* Note that this option was not covered during the workshop process
P indicates 'Potential' combinations with limited precedents and greater delivery uncertainty.

It is beyond the scope of this report to fully research all 36 combination options and beyond the resources of the participating councils to support 36 different models of renewable energy deployment. As such, a comprehensive workshop process was conducted to prioritise these options down to those that SSROC should actively pursue. The top five preferred combinations were shortlisted as warranting more detailed analysis of their economic viability. The prioritisation process employed was as follows:

[17] Note only 33 combination options were identified at the workshop stage of the project, subsequent combination options have been identified and are included for comprehensiveness.

Step 1: Establish multi-criteria analysis framework

This entailed identifying decision making criteria or factors against which the combination options could be assessed. The criteria can be found in Appendix E. They included energy generating potential, the social equity of the option and indicative economic viability.

Step 2: Prioritisation workshops with council, community and business stakeholders

During the workshops participants were asked to weight (rate the relative importance) of the different criteria and identify new criteria for how these combinations should be assessed. Additionally, participants were invited to identify (star) those combination options they thought should be prioritised within the *Our Energy Future* Process. As such, both objective (multi-criteria analysis) and subjective (starring of options) prioritisation processes were undertaken. A detailed methodology of this prioritisation process is given in Appendix E, including the full range of criteria and the results of the criteria weighting.

Step 3: Synthesis of prioritisation workshop results

From these results, expert opinion and analysis of the technology and delivery model "combination options" using some of the additional criteria identified by participants during the workshop, the ISF project team recommended 11 top "combination options". These were presented to the Our Energy Future Steering Committee (representatives from each participating council as well as SSROC). Based on the outcomes of their review, five options were prioritised for detailed economic analysis in the Renewable Energy Master Plan. A further three options were identified as priorities for the Renewable Energy Master Plan and are discussed in detail in Section 6 but no additional economic modelling was undertaken. These eight options and the associated prioritisation rationale are outlined in Table 6 and Table 7 below.

Table 6: Priority Technology/Delivery Model options for economic modelling

Combination Option	Rationale for prioritisation
1. Solar PV – Leasing (business)	Commercial solar PV has significant renewable energy generating potential in the SSROC area and the associated models are applicable to both council operations and businesses in the participating LGAs. As with the residential leasing model, the *Our Energy Future* Steering Committee was interested in understanding more about innovative commercial solar delivery models.
2. Solar PV - Leasing (residential)	Residential solar PV represents the single largest source of renewable energy potential in the SSROC areas. Workshop participants and the *Our Energy Future* Steering Committee were interested in exploring in more detail new and innovative models of deploying residential solar PV. As such, solar leasing was chosen for more exploration. Additionally, it scores highly in all workshop prioritisation processes except the business MCA, thus indicating that this option performs well across most criteria. It is also one of the main delivery model options available to more socially marginalised groups.
3. Solar PV - Community Ownership	Community owned solar scored within the top five for four of the six workshop prioritisation processes, predominantly in the tally process, indicating there is a wide amount of stakeholder support for, and interest in, the option, and as such was prioritised for further investigation.
4. Large Wind - Urban Regional	The *Our Energy Future* Steering Committee was interested in exploring an Urban Regional Partnership, as a new and innovative

Partnership	renewable energy model. Given that wind is the most cost effective renewable energy technology, it scored well in the council and community MCA and is the most likely urban regional partnership technology option to be economically attractive in the near-term.
5. Bioenergy (anaerobic digestion) - Council Partnership with an Energy Company	This combination option would also take advantage of the collective power of SSROC and concurrently address council waste issues, which was an additional criteria identified in the council workshop. Further, bioenergy was identified as being of particular interest in both the council and community tally processes.

Table 7: Additional priority Technology/Delivery Model options

Combination Option	Rationale for prioritisation
6. Solar PV - Bulk Buy	A solar PV bulk buy or brokering program by SSROC councils scored well on every prioritising process undertaken in the stakeholder workshops. There is significant interested from councils in developing such a program and as such forms a core part of the *Our Energy Future* Renewable Energy Master Plan. However, it is not chosen for economic modelling, as essentially, the economics of residential solar PV are known, so, for SSROC, it is primarily about developing a well-designed and effective program.
7. Solar PV - Council Ownership	As a council initiated process that highlights the cost effectiveness of commercial scale solar PV, council ownership of solar is a key recommendation from the *Our Energy Future* project. However, because of the site-specific nature of detailed solar PV assessment for participating councils, this is beyond the scope of this project, so this option has not had additional economic modelling undertaken.
8. Solar Hot Water for Pools – Council Owners	While this option did not score in the top five for any of the prioritisation processes, it nonetheless represents a significant renewable energy opportunity for participating councils and as such was considered worthy of more detailed explanation within the Renewable Energy Master Plan.

6 DETAILED ANALYSIS - PRIORITY TECHNOLOGY/DELIVERY MODEL OPTIONS

In this section, the business model, stakeholder roles, detailed economic analysis, key considerations and next steps of the five priority combination options are outlined. For the additional three options a detailed description and next steps are provided. Based on this analysis recommendations have been developed for actions that SSROC councils should actively pursue as part of the *Our Energy Future* Master Plan.

A summary of all eight options and the associated key roles are provided in Table 8. Note the options detailed are ordered by technology, rather than priority i.e. all of the solar PV options are discussed consecutively. In particular, commercial solar options – business leasing/PPA, council ownership and community ownership are grouped together for ease of comparison, as they all require the same type of host site.

Table 8: Stakeholder roles for the prioritised renewable energy/delivery model combination options

	Renewable Energy Models							
	Solar PV					**Wind**	**Bioenergy**	**Solar Hot Water**
	Commercial Leasing/PPA	**Council ownership**	**Community Ownership**	**Residential Leasing/PPA**	**Brokering (bulk-buy)**	**Urban/ Regional Partnership**	**Council Partnership with an Energy Company**	**Council Ownership (pools)**
Host	Commercial building owner	Council	Commercial building owner	Residential building owner	Residents	Regional land owners	Energy Company	Council/ community pools
System owner	Solar developer	Council	Community special purpose organisation	Solar developer	Residents	Wind developer	Energy Company	Council
Project developer	Solar developer	Council and Solar developer	Community special purpose organisation	Solar developer	Council and Solar developer	Wind developer	Energy Company	Council and Solar hot water developer

Renewable Energy Models									
	Solar PV					Wind	Bioenergy	Solar Hot Water
	Commercial Leasing/PPA	**Council ownership**	**Community Ownership**	**Residential Leasing/PPA**	**Brokering (bulk-buy)**	**Urban/ Regional Partnership**	**Council Partnership with an Energy Company**	**Council Ownership (pools)**
Project financer	Third party investors	Council	Community investors	Third party investors	Residents	Wind developer and third party investors and/or Council & urban community members	Energy Company	Council
Project financial beneficiaries	Commercial building owner (elec. bills) Solar developer (fee) Third party investors (return on investment)	Council Solar developer (fee)	Commercial building owner (elec. bills) Community special purpose organisation and its members – community investors	Residential building owner (elec. bills) Solar developer (fee) Third party investors (return on investment)	Residents Solar developer (fee)	Wind developer and third party investors and/or Council & urban community members	Energy Company Council (if cheaper than landfill)	Council Solar hot water developer (fee)

6.1 COMMERCIAL SOLAR PV

Three of the prioritised delivery models – business leasing/PPA, community ownership and council ownership are models of commercial scale solar PV. Commercial solar PV has a significant technical potential in the eight participating SSROC council areas (495 GWh/yr), although not as much as residential solar PV. In recent years the market for commercial solar PV has matured to the extent that consumers now have the option of coupling a solar PV system with a financing offer to overcome the barrier of upfront cost. However, whilst commercial consumers including councils now have more choice, this has come with increased financial complexity.

There are four main payment mechanisms currently available to businesses and councils wishing to install solar PV. The two most common are 'Upfront payment' and 'debt financing', whereby the solar PV host also owns the system in its entirety. The alternatives to ownership are when the solar PV system host (in this case a commercial building owner) utilises financing mechanisms known as 'solar leasing' and a 'solar power purchase agreement' (PPA). The leasing and PPA option can be facilitated either by a solar developer or a specially developed community renewables organisation.

In this Renewable Energy Master Plan solar developer led business leasing/PPA is the first model discussed with the economics compared to upfront payment and debt financing. Council ownership through upfront payment or debt financing is then outlined. The final model outlined is a community renewables approach to solar leasing/PPA.

6.1.1 Leasing and Power Purchase Agreements

Technology: *Commercial solar PV*
Delivery model: *Leasing and PPAs*

Description

Solar leasing or PPA is where a solar developer installs and owns a solar PV system on the host's roof. The host agrees pay for the use of the PV system through a regular payment in return for being able to use the electricity and thus benefit through electricity bill reduction – meaning that the host may be financially ahead from day one. This payment to the developer may be in the form of a regular predetermined amount (a solar lease) or tied to how much solar electricity the system actually generates in kWh (a power purchase agreement). These options are discussed in more detail in the 'delivery models' section of the report (Appendix D).

Commercial businesses and councils should choose a financial offer that is most suitable to their individual circumstances. Factors such as access to savings, amount of daytime electricity use and system size are all important considerations when choosing a financing offer. To assist, ISF has created a Microsoft Excel-based financial model that enables straightforward comparison of the different financing mechanisms. ISF has modelled the financial benefits of solar power under each of the different scenarios (Economic Evaluation section below). Given that solar leasing was chosen as a priority, the specific implications of the commercial solar leasing or PPA model are discussed in detail.

Commercial scale solar leasing and power purchase agreements are largely identical to residential solar leasing and PPAs (discussed in Section 0), albeit on a larger scale. Certain factors relevant to commercial electricity use means that the economic outcome for the host from such an agreement may actually be more attractive than to residential hosts, depending on the circumstances. For example, commercial buildings tend to have a more dominant daytime electricity demand, which increases the likelihood of a higher effective rate of power purchase (due to a better matching of timing of generation and demand). Furthermore, businesses often have a greater tendency than residential households to lease for purposes of cashflow and capital constraints.

Host site: Commercial rooftop or vacant land adjacent to commercial site.
Who owns the system: The solar developer
Who develops the project: A solar developer

Financial flows and benefits

A solar developer facilitates third party investors to pay for the upfront costs of capital and installation. The business who hosts the system pays a regular lease payment or per kWh payment to the developer for use of the solar PV system. The developer repays the investor through debt repayments or dividends.

In any solar lease or PPA agreement the host (i.e. the commercial business) essentially shares the ongoing profits of the solar PV system with the funder and the owner/developer. The financial flows are displayed in **Figure 14** below.

Economic evaluation of commercial solar leasing and PPAs

When assessing the economic benefits of solar leasing over the course of the lease, investment indicators such as rate of return or payback period are not relevant as there is no capital investment from the perspective of the host organisation. To allow straightforward visual comparison of the value of installing the solar panels over time, we have modelled the net financial position (i.e. net profit) from the host's perspective, relative to not installing solar panels, over the life of the solar panels for the different financing mechanisms. Put differently, the net financial position is the sum of all annual cashflows (annual costs and benefits) at a point in time. This method also allows visual interpretation of the upfront cost (the initial deficit in the first year) and also the payback year, which occurs when the line crosses the x-axis. Annual cashflow can be visually gauged by the upward sloping line – the steeper the slope, the higher the annual positive cashflow.

We have modelled the economic benefits of different financing mechanisms for a hypothetical large commercial rooftop PV system of 99kW[18] installed in Sydney with a high on-site solar energy utilisation of 95% on a site with a Time of Use (ToU) tariff structure. Such a configuration would only be possible on a building with a minimum base load demand load of 100kW[19]; meaning this installation would be for a relatively large energy user, not unlike what you would see at a council administration building or depot.

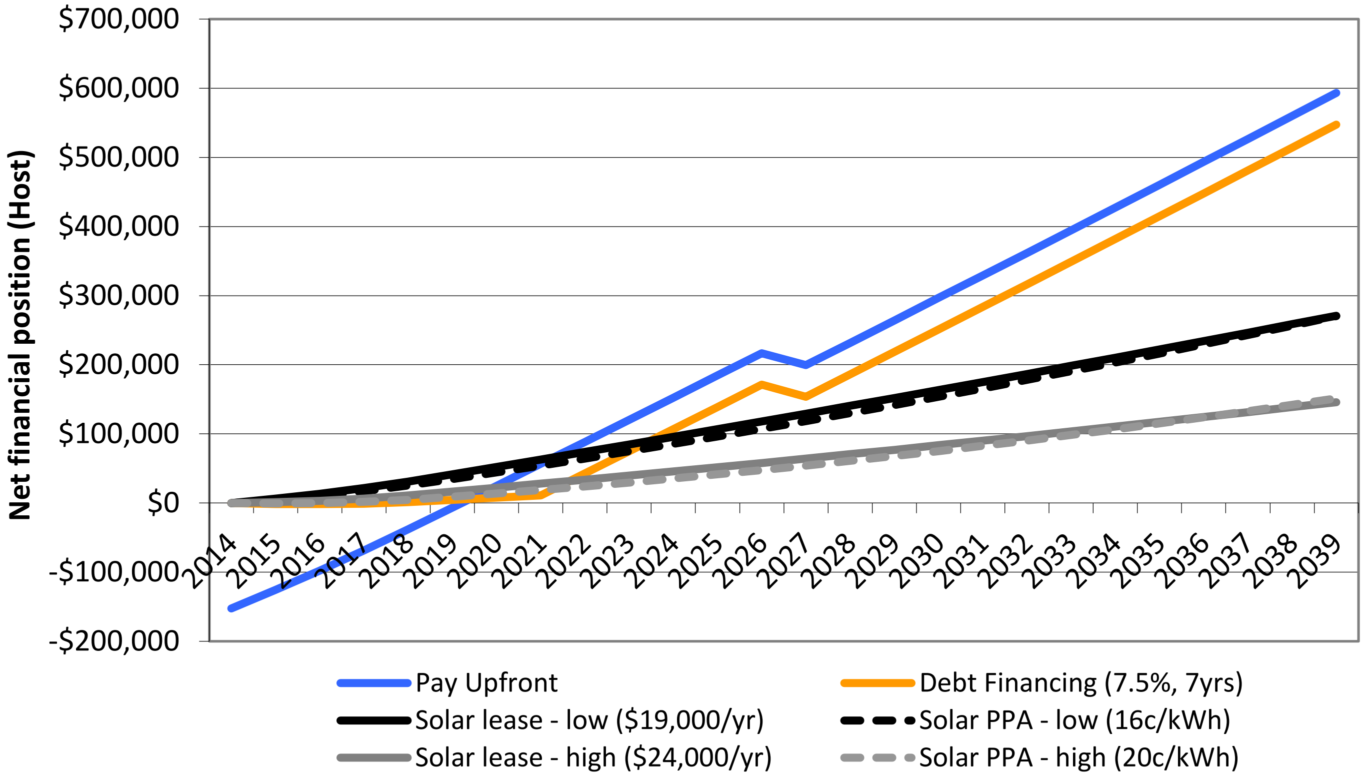
The economic benefits of different financing mechanisms are summarised below in Figure 14. As can be seen the solar leasing and PPA options are cash-flow positive from the first year, and have the host in a better financial position relative to the 'pay upfront' and 'debt financing' options for the first five to eight years.

As can be seen, when the host own the panels and has finished paying off the system, the annual positive cashflow is much higher that when in a lease or PPA. This is evident by the steeper increase in net financial position for both the 'pay upfront' and 'debt financing' option after all debt has been repaid. In year 13, a forecast inverter replacement causes a dip in the curve for these two options, which is not the responsibility of the host in a leasing or PPA contract.

[18] 99kW is selected as systems of 100kW+ are liable for increased network connection charges.
[19] Base load of a building is the load that is drawn or the amount of electricity that is used consistently 24 hours a day, 7 days a week.

Note: that the solar lease and PPAs modelled here assume that the host continues to lease for 25 years, which may not always be the case. Most lease and PPA contracts include provisions for outright purchasing of the system at or during the contract term at a predetermined price. Some contracts may even gift the system to the host at the end of the contract. From the host's perspective, the annual benefits are highest when owning the system outright and therefore the possibility of purchasing or being gifted the system should be considered at some point to maximise the rate of return in later years.

Figure 14: The host's net annual cashflow from a commercial solar PV under different payment mechanisms



Assumptions: Sydney, 99kW system, 95% on-site solar energy utilisation, medium electricity price scenario[20]*, ToU pricing based on council electricity prices.*

Key Considerations

The following considerations are especially relevant for commercial solar PV hosts. Additional considerations that apply to both commercial and residential hosts are discussed in Section 6.2.1.

The host building must have a sufficiently high initial electricity price

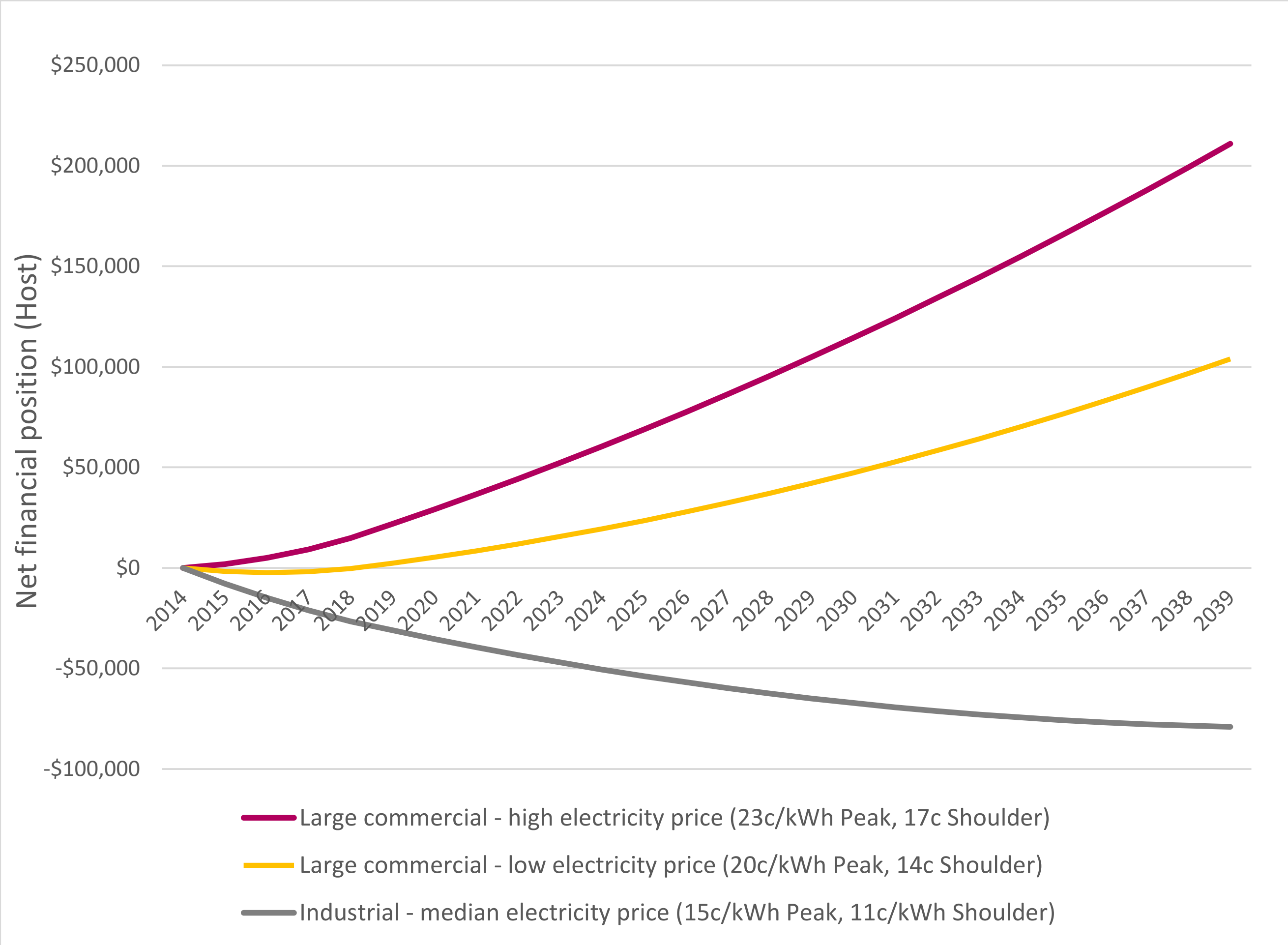
The c/kWh electricity price can vary substantially from building to building in the commercial sector. Figure 15 below demonstrates that an example solar PPA of 18c/kWh will only provide significant benefits to the host if the building has a sufficiently high grid electricity price in year 1. If the grid electricity price is too low, for example, for example, for the industrial customer with a 15c/kWh peak grid electricity price, then a solar PPA of 18c/kWh is unviable, as shown by the industrial customer returns in Figure 15. If the initial peak grid electricity price is higher, for example, 20c/kWh

[20] Medium electricity price scenario assumes a 5% annual electricity price increase to 2019 and a 1% from 2020-2038.

and above, then this modelled solar PPA will offer substantial benefits to the host, as shown by the commercial examples below.

Note: We have modelled based on time-of-use (ToU) pricing as most large energy uses face such tariffs. Having a flat tariff may not significantly alter the economic outcomes of installing solar panels, as usually these sites are smaller energy users with less bargaining power and so face higher per kWh rates.

Figure 15: The impact of initial electricity price on the financial benefits of a solar PPA



Assumptions: Sydney, 99kW system, 95% on-site solar energy utilisation, medium price forecast, 18c/kWh PPA

Must have high on-site solar energy utilisation

Commercial premises need to ensure that they utilise as much of the solar electricity on site as possible. Commercial premises should aim for 100% solar utilisation as their demand loads are often steady and coincident with sunshine hours.[21] 100% utilisation means that all energy is used on site, and none is exported to the grid. This is important as the average price paid for solar electricity exported to the grid is 6-8c/kWh, while if it is used onsite, it offsets the retail electricity rate (in this case assumed to be 20c/kWh at peak times). Given the difference in price between onsite use and export, the economics of solar energy are much more favourable if onsite use is maximised.

[21] We have modelled commercial solar utilisation at 95% to account for potential PV system downtime due to unforseen electrical maintenance, or demand factors such as blackouts or public holidays which may reduce the demand below the solar output.

Tenants face additional complications
Commercial tenants (even if they hold long term leases) do not have the authority to install grid-tied solar panels to the roof of their building as the site owner is responsible for connecting to the distribution network service provider. Where tenants have long-term leases (very rare) that match the solar lease term, the tenant is in a reasonably strong position to negotiate with the landlord to connect the solar array. Where the building lease is shorter than the solar lease council could explore possibilities with solar leasing companies to facilitate a risk sharing arrangement that addresses the split incentive associated with the landlord tenant relationship.

Council role

Council as a Host
The council could directly install a solar PV system on its own buildings or sites utilising a solar leasing or PPA arrangement. This could be an attractive option from a local government perspective as it could be designed to be fiscally positive from day one, and councils typically have high and stable daytime demand in their buildings, relatively high commercial electricity prices, and usually own their sites meaning they have additional security over long-term solar revenue compared to a commercial tenant who is more inclined to move premises over the course of the solar lease or PPA.

Council as information provider
Local governments could drive local uptake by the provision of independent and local information to assist local businesses in making a wise financial decision when installing solar PV. This could be in the form of factsheets, information sessions, solar assessments (in person, online, or on the telephone) and so on. The council could implement such actions themselves or contract third party organisations. The information contained in this chapter, including the resource links in Appendix D, provide useful preliminary information for councils wishing to provide residents with information.

Council as planner
Councils could incorporate provisions and requirements for solar into their asset management plans and land use plans. More detail about the planning role of council is given in Section 7.3.

6.1.2 Council Ownership

Technology: *Commercial Solar PV*
Delivery model: *Council Ownership*

Description

Council ownership of solar PV is straightforward; it involves council funding, commissioning and owning a solar array, typically on one of its buildings.

Host site: Council
Who owns the system: Council
Who develops the project: Council with the support of a renewable energy developer

Economic evaluation of council ownership

As shown in Figure 14, the initial capital investment requirements for council are high if funded through savings, but the ongoing and overall financial outcomes are greater as the annual rewards are not shared with third parties.

Council Role

The council could directly install a solar PV system on its own buildings or sites utilising a solar leasing or PPA arrangement (as discussed above). This could be an attractive option from a local government perspective as councils typically have high and stable daytime demand in their buildings, relatively high commercial electricity prices, and usually own their sites meaning they have additional security over long-term solar revenue.

6.1.3 Community ownership

Technology: *Commercial Solar PV*
Delivery model: *Community investors + Lease or power purchase agreement.*

Description

A commercial solar PV project is developed and owned by a cooperative or company made up of community members, in conjunction with a PV host who buys and uses the solar electricity via a solar lease or PPA. While members of community solar projects would like have the electricity generated by their community solar array on a nearby roof credited against their electricity bill, the institutional arrangements of the energy market make this difficult (and currently impossible) to do. See a discussion of Virtual Net Metering in Section 7.4 for more explanation.

Host site: the rooftop of a host's building, or vacant land adjacent to the host's building. The host will likely be a commercial or government organisation with relatively high energy consumption.

Who owns the system: the community cooperative/company owns the system. The building host also has the opportunity to invest into the community project by becoming a community investor, meaning that the host can yield a double-dividend as both a host and owner/developer.

Who develops the project: In its early stages of feasibility assessment, a project would typically be developed by a local community group who may receive assistance (advice, technical assistance, capacity building etc.) from community renewable energy support organisations (such as Community Power Agency[22] or the Alternative Technology Association). Alternatively, the feasibility assessment of a project may be driven by a social enterprise (such as Embark or Farming the Sun). In all cases a new entity will be formed to channel the community investment and undertake the construction and management of the project. This entity may be in the form of a:

- Cooperative;
- Private Company;
- 'B' (or benefit) Corporation. This is a new corporate model being developed that aims to provide a legal structure for companies who wish to create benefit for all stakeholders rather than just shareholders.

Financial flows and benefits

The upfront costs come from equity investment from community group members, who may include:

- Individuals ('mum and dad' investors)
- Small businesses

[22] Disclosure statement: the lead author of this report is also a Director of the Community Power Agency.

- Councils
- Local NGOs/charities/sustainability groups

The upfront cost and shareholder profit is recouped via ongoing solar lease or PPA payments from the host, who pays for the solar electricity generated by the system.
Revenue can be used to:

- Pay-off debt
- Returned to members as a dividend
- Seed a new project
- Setup a community grant fund

Economic evaluation of community solar leasing and PPAs

With the community solar business model the economic outcomes from two important local stakeholder perspectives – that of the host, and that of the community investors need to be addressed.

As part of this project the investment and host outcomes of a single hypothetical project with a 21c/kWh PPA and a 25-year contract term has been analysed. Also note all annual profits are assumed to be returned to investors as a dividend and therefore interest on cash reserves are not included in the analysis.

Table 9: Inputs in modelled community solar project with PPA

Hypothetical project assumption	Assumed data input	Comment
2014 PPA price	0.21c/kWh	Flat price (rises only with CPI)
PPA term	25 years	Matches technology lifespan
Host's electricity prices (2013)	Peak: 23c/kWh, Shoulder: 0.17c/kWh, Off peak: 0.09c/kWh	Based on average SSROC council electricity prices for admin, depot and aquatic facilities in 2013.
Forecast electricity price growth	Medium price growth scenario	Increasing 5% per year till 2019 1% thereafter
System Size	99kW	
System location	Sydney	
System capacity factor[23]	17%	
Upfront capital and installation costs	$150,000	Based on $1.5/watt incl. connection costs
Upfront other costs	$30,000	Estimated costs for establishing an entity, feasibility, and consultant fees
Ongoing finance and management costs	$10,000	Estimated ongoing costs such as financial management, maintenance, insurance
Host's solar utilisation	99%	Assumes energy demand of the building is always higher than solar generation except for demand or solar outages.

The financial analysis above assumes that the community group are able to utilize substantial pro-bono or discounted work for example to cover legal and technical assessment costs. The analysis accounts for factors such as solar PV performance degradation, inverter replacement, ongoing financial management and profit taxes.

Table 10: Host financial performance summary

Bill reduction	Year 1 bill reduction (savings)[24]	$29,243
	Year 1 lease, PPA or loan payments	$30,960
	Year 1 net balance	- $ 1,717
Profit	10 Year cumulative profit	$33,174
	25 Year cumulative profit	$158,349

[23] Capacity Factor refers to a ratio of actual energy output over a period of time compared to if the plant operated at full rated capacity for the whole period. As an equation: Capacity Factor = Energy generation (kWh/yr)/Generator size (kW)/# hours in a year) x 100

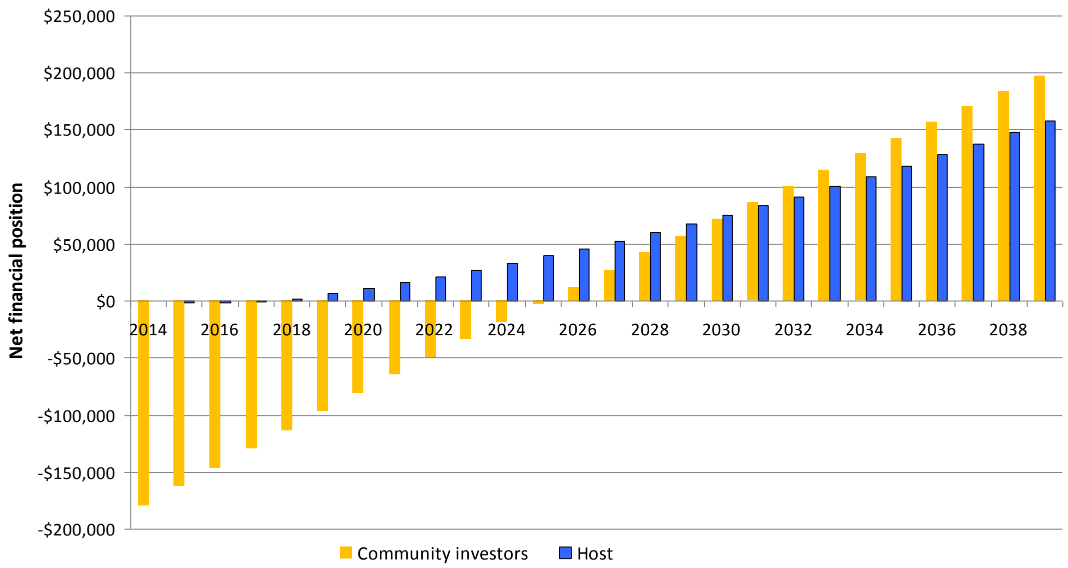
[24] Note solar PV won't replace all of a commercial building's energy use under the modelled scenario (in fact this is only possible if combined with a large energy storage system).

	25 Year NPV profit	$90,492

Table 11: Community investor financial performance summary

Year 1 cashflow	Revenue from PPA	$30,960
	Annual Ongoing costs	- $10,000
	Taxation	- $ 4,128
	Net cashflow	**$16,832**
Collective Profit	10 Year cumulative profit	-$18,377
	25 year cumulative profit	$197,648
	25 year NPV profit	$69,747
Other investment indicators	Simple payback	12 years
	ROI (1st year)	9.0%
	ROI (Ave annual ROI, 10 years)	7.4%
	ROI (Ave annual ROI, 25 years)	5.5%
Per $100 share	10 Year cumulative profit	- $37
	25 year cumulative profit	$399
	25 year NPV profit	$141

Figure 16: Net financial positions of example community solar: Host v community investors



As demonstrated in the tables above, such as project can be designed to provide mutual economic benefits for both the host and the community investors. From the perspective of the community investor, the project compares favourably to many other long term investment opportunities in terms of both risk and return. In addition such a project also allows renters, apartment dwellers, and other residents whose rooftops are unsuitable for solar PV to participate in renewable energy investment. From the host's perspective, the host pays slightly more that grid electricity in the initial years of the agreement, but the benefits increase in time with rising grid electricity prices to total almost $160,000 by the end of the 25 year term.

A community renewable energy project such as this has far greater benefits than just the financial benefits modelled here; several of which reflect those raised by community stakeholders during their workshop. Additional benefits include

- localised energy supply and money from renewable energy investment stays in the community
- providing an ethical investment opportunity for mum and dad investors
- social benefits from community development such as increased energy literacy, individual capacity building, strengthened community networks and more
- emissions reductions
- full ownership by the community which allows complete democratic control over the infrastructure
- provides the community with a landmark solar PV project which could catalyse further local renewable energy projects.

Key Considerations

All of the key considerations outlined in the commercial solar leasing/PPA analysis (Section 6.1.1 above) apply to Community ownership as well. One additional consideration is when a host site invests.

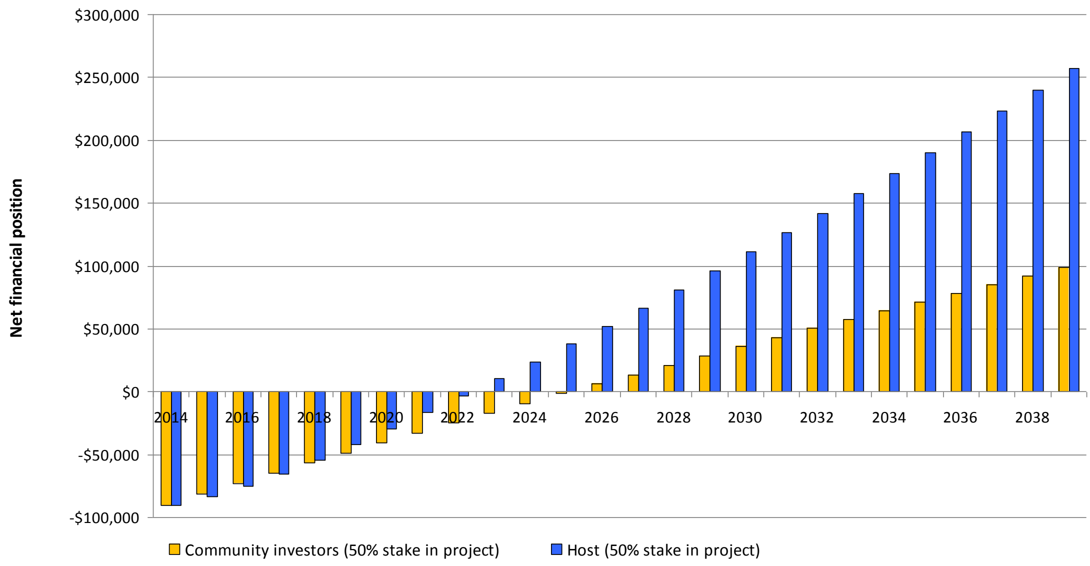
Host invests to yield a double dividend

If the host wishes to extract more benefit from the solar PV system, they can reap a double dividend by investing in the upfront costs of the project as a community group investor. This may be of particular interest for a council, as such a 'local government-community' investment partnership is an innovative financing arrangement which could have strong community support and attract media coverage. Additionally, council investment in the community entity would enable a quicker roll-out of renewable energy capacity on council buildings, which could substantially improve the profitability of community investment solar PV due to improved economies of scale.

Figure 17 below shows the financial position to both the host (in blue) and the remaining community shareholders (in yellow) if the host invests upfront into the project as a 50% shareholder. In this example, the PPA arrangement assumptions are identical to the example in Figure 16, however the host acts an investor in the community entity by investing $90,000 of its own savings into the entity, which is 50% of the total required capital fundraising costs of $180,000. By doing so, the host would receive the same annual benefits as in Figure 16 through lower net electricity bills, but in addition would receive an annual dividend from being a 50% shareholder in the community investment entity. The blue columns in Figure 17 show the effect of the host's combined benefits from both bill annual reduction and the investment dividend. Of course, by investing capital, the host is no longer in the revenue neutral position we see for the initial few years in Figure 16, but the long run benefits are substantially higher.

Note that as this is the same 99kW project that is modelled above, the aforementioned economies of scale benefits are not relevant here and therefore excluded. Similarly, potential upfront savings related to lower levels of community fundraising have not been included.

Figure 17: Net financial positions of example community solar PV project. Host v community investors (50:50 stake in project)



Council role

Council as a Host

The council could directly install a solar PV system on its own buildings or sites utilising a solar leasing or PPA arrangement. This could be an attractive option from a local government perspective as it could be designed to be fiscally positive from day one, and councils typically have high and stable daytime demand in their buildings, relatively high commercial electricity prices, and usually own their sites meaning they have additional security over long-term solar revenue compared to a commercial tenant who is more inclined to move premises over the course of the solar lease or PPA.

Council as information provider

Local governments could drive local uptake by the provision of independent and local information to assist local businesses in making a wise financial decision when installing solar PV. This could be in the form of factsheets, information sessions, solar assessments (in person, online, or on the telephone) and so on. The council could implement such actions themselves or contract third party organisations. The information contained in this chapter, including the resource links in Appendix D, provide useful preliminary information for councils wishing to provide residents with information.

Council as planner

Councils could incorporate provisions and requirements for solar into their asset management plans and land use plans. More detail about the planning role of council is given in Section 7.3.

6.1.4 Recommended Next Steps

Install solar on all viable council roofs

Participating SSROC councils should actively pursue council solar PV systems. This will entail identifying high priority sites for the installation of solar PV; these should be sites with appropriate tariffs, roof area, orientation and daytime electricity demand. An analysis should then be undertaken to determine which delivery model would be most appropriate for each site – direct ownership, leasing/PPA or community ownership. ISF’s Solar Financing Model could be used to conduct such an analysis. When going to tender it will be important for council to know the optimal system size and price given the buildings specific energy profile and electricity tariff.

Support the development of community solar projects
SSROC should proactively support the development of community solar projects. This would involve:
- Helping to identify and develop a register of potential community solar host sites, including council buildings
- Providing seed funding for community solar projects
- Promoting community solar to council residents, particularly renters and apartment residents
- Having council sustainability or community development officers participate in the development of community renewable energy projects (optional)

Provide commercial solar information
SSROC should provide information to commercial building owners and tenants to help them install solar either through direct ownership, debt financing, community ownership or a leasing/PPA arrangement.

Create a trusted list of commercial solar PV developers
Similar to the residential solar brokering (bulk-buy) scheme outlined in Section 6.2.2, SSROC should develop a tender process for a panel of trusted/recommended solar PV developers. This panel of solar developers should ideally include those that offer a range of financing delivery model options – upfront payment, leasing/PPA and debt financing.

6.2 RESIDENTIAL SOLAR PV

This section outlines the two main prioritised options for increasing the uptake of residential solar PV in the participating council areas – leasing (Section 6.2.1) and council brokering or bulk buy program (Section 6.2.2).

Residential solar PV has a very large technical potential in the eight participating SSROC council areas (1,360 GWh/yr). It should be noted that this level of solar PV penetration (albeit technical rather than economic potential) in the residential sector would present technical integration challenges for local distribution network service providers if there is net export from many residential PV systems. This is discussed in more detail in Section 7.4.

6.2.1 Leasing and power purchase agreement

Technology: *Residential Solar PV*
Delivery model: *Leasing and PPAs*

Description

As with the commercial sector, in recent years the market for residential solar PV has matured to the extent that consumers now have the option of coupling a solar PV system with a financing offer to overcome the barrier of upfront cost. Whilst consumers now have more choice, this has also come with increased financial complexity.

As with the commercial sector four main payment mechanisms are currently available to residents wishing to install solar PV – 'Upfront payment', 'debt financing', 'solar leasing' and 'solar power purchase agreement' (PPA). To explore these, as with the commercial solar leasing options, ISF has taken an average household and modelled the financial benefits of solar power under each of the four different payment mechanisms. Given that solar leasing was chosen as a priority by the Steering Committee, the specific implications of the residential solar leasing or PPA model are discussed in detail.

Host site: Residential rooftop
Who owns the system: The developer owns the system
Who develops the project: A solar developer owns, installs and maintains the system. However, the residential household will typically initiate the project's development and is in mutual agreement with the developer on the terms of the agreement.

Financial flows and benefits

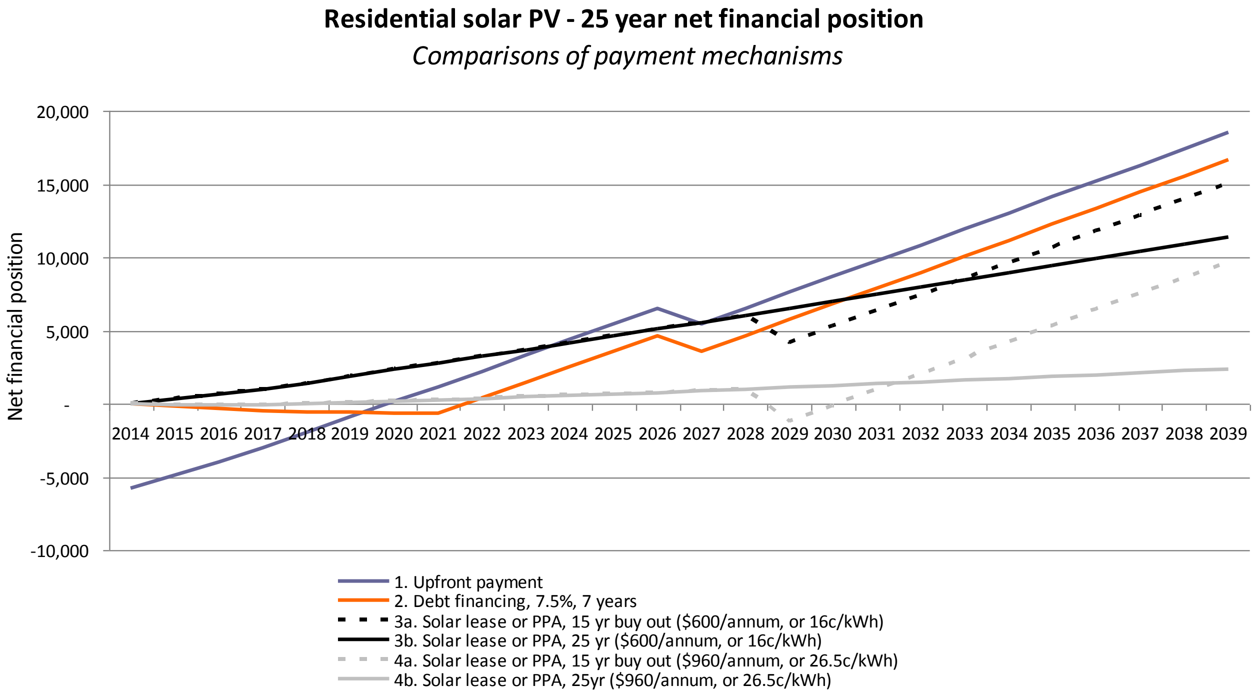
The financial flows and benefits are identical to commercial solar leasing and PPA, only in this case with a household as the host (see 6.1.1). That is a solar developer facilitates third party investors to pay for the upfront costs of capital and installation. The household who hosts the system pays a regular lease payment or per kWh payment to the developer for use of the solar PV system. The developer repays the investor through debt repayments or dividends.

In any solar lease or PPA agreement the host (i.e. the householder) essentially shares the ongoing profits of the solar PV system with the funder and the owner/developer.

Economic evaluation of residential solar leasing/PPA

As shown in Figure 18, the solar PV host (the household) pays for the use of the system through ongoing lease or PPA payments. The host is actually sharing the profits of the solar PV system with the owner/developer and the funders, who receive a return on their investment as and when the payments are made. As expected, the benefits available to a residential host are therefore lower than if the host owns the system outright, as shown in Figure 18 below.

Figure 18: The net financial benefits of residential solar PV under different payment mechanisms



Assumptions: Sydney, 3kW, 75% solar utilisation, medium electricity price forecast

The figure above compares the financial benefits of different solar financing options for a 3kW system in Sydney installed in 2014, on the roof of a household with relatively high daytime energy use (solar utilisation of 75%).[25] As expected, if the householder pays upfront (scenario 1), they receive a greater overall profit over the lifespan of the solar panels, with a payback period of 6 years. If the householder cannot afford the upfront capital, debt financing with a competitive interest rate will provide relatively high net profit over the lifetime of the solar panels compared to most solar leasing or PPA offerings. A competitive solar lease or PPA (Scenario 3) will provide immediate bill savings and the householder will find themselves financially ahead of all other alternatives until 2024. A more expensive solar lease or PPA (scenario 4) would lead to only a marginal positive annual net cash flow. As can be seen in both solar leasing/PPA scenarios, if the householder purchases the system outright at any stage – as shown by 3a and 4a (where the system is purchased at the end of the 15-year lease term) – then full ownership benefits accrue to the householder.

Key Considerations

The price of the lease or PPA

As can be seen above, the benefits of a solar lease are highly dependent on the leasing or PPA price. A competitive price may provide substantial benefits from the outset, whilst a less competitive price, depending on other circumstances, may provide only marginal benefits to the householder over the short and long term.

Buy out the system early for maximum benefits

As can be seen by the solar leasing options in Figure 18, the net annual benefit is substantially higher where the household has bought the system out at the end of the contract. In fact, assuming that exit and buy-out fees are aligned with the value owing on the system, the earlier the system can be purchased, the more the benefits that will accrue to the householder over the lifetime of the project.

Solar utilisation must be as high as possible and can be an economic deal breaker

Solar utilisation is defined here as the proportion of a solar PV systems generation which is utilised by the building. For example: assuming that 75% of all solar electricity is used within the building, and the remaining 25% is exported to the grid, the solar utilisation rate is 75%. Currently in NSW – where we are seeing only low net feed-in-tariffs offered - it is very important to maximise the solar utilisation in order to maximise the financial benefits to flow from any solar PV installation.[26] For those households with low daytime energy use, community solar or waiting a few years until solar PV with storage becomes cost effective are the best options.

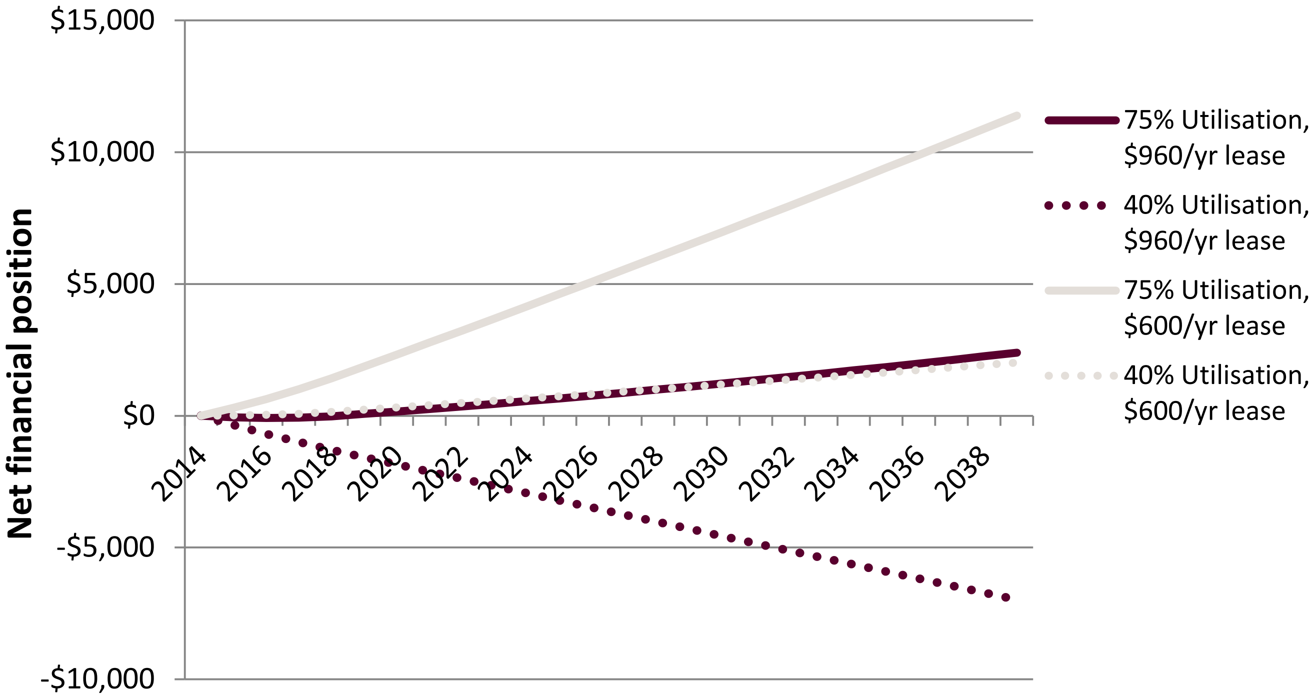
The scenarios in Figure 18 have been modelled on a 3kW system with a 75% rate of solar utilisation. This is relatively high for a residential household and indicates above average daytime electricity demand; for example, it would require that someone is regularly at home during the day operating electrical heating and cooling appliances, washing machines, dishwashers and so on. However, if a household has a lower solar utilisation – for example, if its residents are at work and school during the day - the economic net benefits of installing a 3kW system may be severely reduced or even net negative – meaning that the household risks making a loss on the solar PV system. Figure 19 below highlights how sensitive the financial outcome is to changes in the rate of solar utilisation. As can be seen, with a solar lease payment of $960 per year, a lower solar utilisation rate of 40% results in large annual loss to the householder. Even in the cheaper $600 per year solar lease offer, a 40%

[25] Solar utilisation is the proportion of solar generation over the course of the year which is directly utilised by the building, as opposed to grid exported electricity.

[26] In NSW in 2013, each unit of solar generation offsetting demand earns a household 27c/kWh (the electricity price), compared with exporting to grid, which earns between 0 and 8c/kWh via a net feed-in-tariff depending on the retailer (IPART 2013, MyEnergyOffers).

utilisation leads to a end of life cumulative profit of only ~$2,000 – 10 times less lifetime profit than if purchasing the system outright. (see Figure 18).

Figure 19: The importance of high on-site solar energy utilisation to residential solar leasing



Assumptions: Sydney, 3kW, Medium electricity price forecast.

Due to the importance of having high solar utilisation, households should:

a) carefully consider the impacts of future shifts in their daytime electricity load profile brought on by energy efficiency, changing composition of household residents, changing work arrangement of household residents and so on.
b) shift as much electricity load as conveniently possible to times when the sun is shining.
c) size the system appropriately so that solar utilisation is high enough to make the solar leasing or PPA arrangement financial viable.
d) calculate their expected average daytime electricity load to double check the solar developer's calculations of expected solar utilisation, as solar developers have an incentive to overestimate the forecasts for a household. Any contract which includes a guarantee of minimum electricity bill savings should circumvent the incentive for a solar developer to overestimate the rate of solar utilisation.

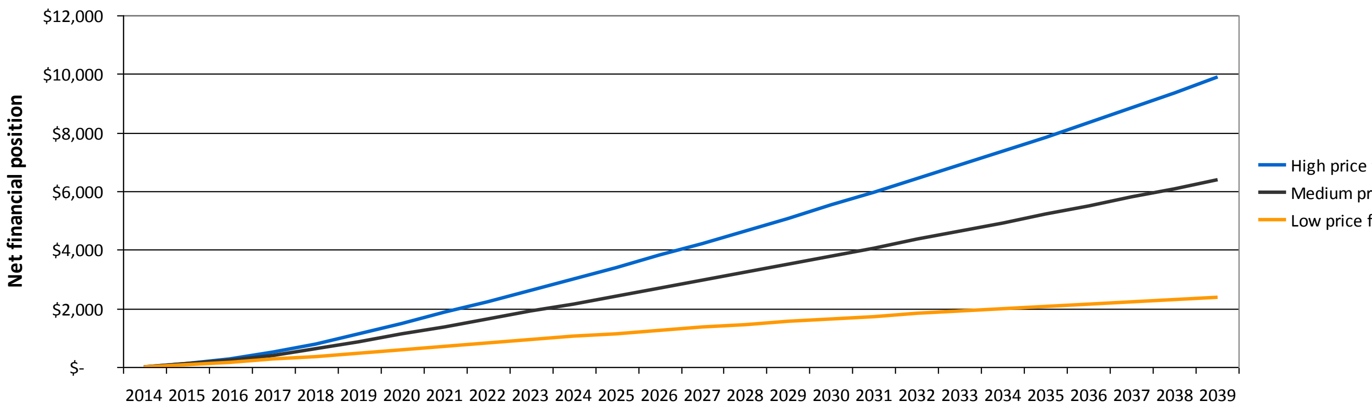
In the next five years energy storage technology costs are projected to come down significantly and as such will play a big role in helping commercial and residential customers to increase their solar utilization and thus the economics of solar PV are likely improve.

Whilst the above considerations are important for all net feed-in-tariff solar PV installations, it is doubly important with solar leasing or PPA agreements as the benefits are lower than with outright ownership and the contract is binding. Note that the importance of solar utilisation is lessened if a relatively high net feed-in-tariff rate is in place, which is currently not the case for new installations in NSW.

Future electricity prices impact on the financial benefits

As with any solar installation, future electricity movements will impact on the profitability of the project. This is a very important consideration with solar leasing and PPA agreements, as the householder is sharing the profits of the solar system,[27] but still accepting all exposure to the risk of lower-than-forecast future electricity price movements. Households need to be wary of the forecasts used by solar developer companies as they can use high electricity growth rates in their calculations.

Figure 20: Impact on future electricity prices on solar leasing/PPA profitability



Assumptions: Sydney, 3kW, 75% solar utilisation, $800/annum solar lease or 22c/kWh PPA.

Check contract terms carefully

It is very important that the householder carefully considers all of the contract terms to ensure that the solar lease or PPA agreement is right for the household. Some important considerations include:

- maintenance and operation obligations
- term length
- early exit fees
- buyout value calculation methodology
- future adjustments of lease of PPA pricing i.e. is the lease flat (typically pegged to the consumer price index), or pegged to electricity price movements?
- options when moving house

Council Role

Information provision

Local governments could drive local uptake by the provision of independent and local information to assist residents in making a wise financial decision when installing solar PV. This could be in the form of factsheets, information sessions, solar assessments (in person, online, or on the telephone) and so on. The council could implement such actions themselves, or contract third party organisations. The information contained here, including the resource links in Appendix D, provide useful preliminary information for councils wishing to provide residents with information.

Vetting

Local government may also be able to partner with one or more pre-vetted solar developers. However, vetting boarders on establishing a Brokering (bulk buy) program outlined in the following section.

[27] This is compared to outright ownership where the household gets all the profits)

6.2.2 Brokering (bulk buy)

Technology: *Solar PV*
Delivery model: *Council Brokering (bulk buy)*

Description

Council brokering for bulk-buy of solar PV involves councils acting on behalf of the community to facilitate a bulk-purchase of PV panels for residential and small business installation.

Under this model, councils would run a tender process for a bulk purchase of panels, and engage a supplier to provide panels at a discounted rate to community members. Community members would then be put in contact with the supplier to procure the panels directly at the discounted rate.

The model differs from a standard bulk-buy arrangement in that a single buyer (e.g. council) is not purchasing the panels, but rather is acting as a broker for a group of community members to enable them to individually purchase the panels at a discounted rate.

This model mitigates financial and other risk for councils as it allows them to facilitate supply of the panels at a discounted rate, however does not require council to purchase the panels (therefore there is no financial outlay) nor to arrange installation. This means that any issues arising throughout the purchase, installation and operation are dealt with through normal consumer law.

Host site: Residential rooftop
Who owns the system: Household
Who develops the project: A third party such as a council or group of councils tender for a reliable and cost competitive solar developer to participate in a bulk-buy solar PV program.

Financial flows and benefits

This model significantly mitigates risk for councils by allowing them to avoid financial outlay for the purchase of the panels. While councils act as a facilitator in the process and engage the supplier, they are not engaged in a financial agreement or obligation with the supplier. Residents deal directly with the supplier, and pay the supplier directly for the cost of the panels and installation. Council does not collect any funds nor does it have any financial liability.

Financial benefits flow to community members through savings on the cost of the purchase and installation of the panels. For example, Parkes Shire Council's recent brokering for bulk buy of solar PV panels delivered savings of $1/watt for community members.

Key considerations

Tendering process

Council would run a tendering process to select a panel of suppliers to provide solar panels at a discounted rate. Important considerations within the tendering process include:

- The quality of panels and installation,
- The reputation of the supplier,
- The rate of discount that the supplier is able to provide, and
- The supplier's capacity (human and other resources) to deliver panels at the expected number.

Size of system

Consideration should be given to setting a maximum size for systems that are to be installed under a bulk-buy program. It is likely to be useful to set this maximum at the same threshold which is determined in the council DCP as being the maximum size system for installation of PV panels without requiring development consent. This will provide an advantage by helping councils avoid an additional development application load that could be associated with a large number of sizeable systems being installed.

Heritage constraints

Consideration should also be given to heritage constraints on some buildings. Councils will need to provide guidance to residents participating in a bulk buy program around their heritage requirements and so as to be sure not to mislead anyone.

Network constraints

Programs which have utilised a bulk-buy model have noted potential problems related to network constraints and the ability of the grid to cope with additional generators. It is important to ensure that residents are aware that delays may exist in seeking approval from the network service provider to install PV and connect to the grid. Understanding approval times and potential delays by communicating with network service providers will be a key strategy for mitigating risk associated with this.

Council Role

Council would need to plan and implement a tender process to identify suppliers. Criteria for the selection of a supplier would need to be carefully considered to manage potential reputational risk for councils in recommending a particular supplier.

Eligibility criteria for residents participating in the program would also need to be considered. The size of systems and other limitations or criteria will need to be clearly articulated to the community.

A recruitment drive would be a key early step for ensuring the success of such a program. Residents should be asked to put forward expressions of interest (with no commitment requirements) to indicate their willingness to participate in the program. This will provide council with a contact list as well as an indication of the likely number of systems that will be purchased through the arrangement.

Note this brokering program could also be extended beyond solar PV products to solar hot water systems. Additionally, the brokering program could be extended in a delivery model sense to include leasing or debt financing models as well as upfront payment models of residential solar PV.

6.2.3 Recommended Next Steps

Develop a council residential solar PV brokering (bulk-buy) program covering both upfront purchase and leasing/PPA options

SSROC should develop a council residential solar PV brokering (bulk-buy) program covering both upfront purchase and leasing/PPA options. This would involve undertaking the steps outlined in the Council Role section above, as well as drawing on the experience of similar council programs, such as that undertaken by Parkes Shire Council. Such a program should be developed with care and due diligence.

6.3 URBAN-REGIONAL WIND ENERGY PARTNERSHIP VIA A POWER PURCHASE AGREEMENT

Technology: *Large scale wind*
Delivery model: *Urban-regional partnership*

Description

Urban regional renewable energy partnerships have the potential to deliver large scale renewable energy generation. ISF has identified three sub-delivery models of urban regional partnerships:

1. Urban council, group of councils and/or community investment in a regional renewable energy project (i.e. a wind farm).
2. Urban council, group of councils and/or large energy users entering into a power purchase agreement (PPA) with a renewable energy (in this case wind farm) developer to source 100% renewable energy from a specific renewable energy (i.e. wind) project.
3. Combination of investment and PPA.

For the purposes of this report ISF has focused in on Option 2 – entering into a PPA. The rationale for this choice is twofold. Firstly, economic modelling of Option 1 would simply be modelling the economics of a wind farm and as such was not considered useful for this project. Extensive information is available about the economics of wind farms, for community investment wind farms good examples are Hepburn Wind, Denmark Wind and CENREC (in development). Secondly, Option 2 presents a new possible model in the Australian energy system and as such is innovative and worthy of further research.

Host site: Regional landholder in partnership with wind farm developer
Who owns the System: A wind farm developer
Who Develops the Project: A wind farm developer

Financing flows and benefits

A wind-farm developer, once planning approval has been achieved, will typically be looking for a long term buyer of the electricity to ensure that the investment is profitable and therefore goes ahead. Councils and large energy users have an opportunity to purchase their electricity directly from the wind farm via a PPA brokered by a third-party retailer.[28] For council this would mean renegotiating their energy contract for at least part of council's operations. The council would benefit from such an agreement by receiving 100% renewable electricity from a known source, at a cheaper price than Greenpower. The benefits for the wind-farm developer are revenue certainty - which in the case of a small wind farm (i.e. <10 turbines) could mean the difference between the development proceeding or not. This could be especially important if the wind-farm developer is a community owned project such as Hepburn Wind.

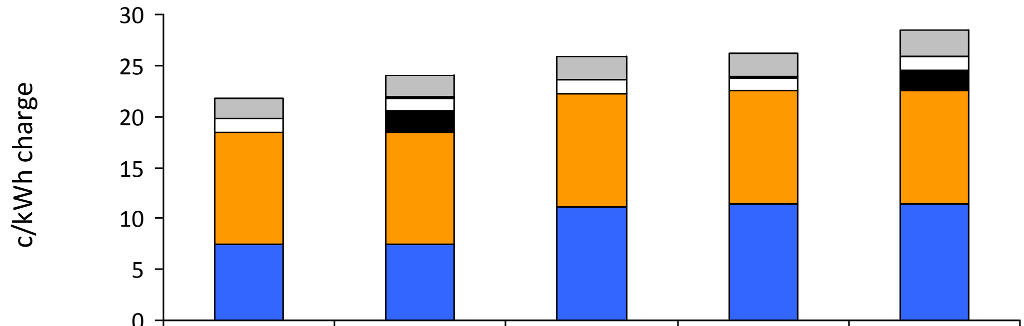
Hypothetically, it is possible to assign the entire generation from a turbine to a council or large energy user; as a guide a 3MW turbine will typically produce about 8,000MWh per annum or sufficient power 1,000 residential households.

Economic evaluation of commercial solar leasing and PPAs

[28] Many windfarm developers are also 'gentailers', i.e. generators with a retail licence. This means that the wind developer will directly broker the deal and manage electricity billing instead of a third-party electricity retailer.

Interviews with two wind farm developers indicated that a PPA for a large energy user could be negotiated at a price of between $80 - $100 per MWh, which includes the benefits obtained by surrendering LRET certificates[29]. By surrendering LRET certificates the energy generation would contribute to meeting Australia's 20% Renewable Energy Target by 2020, but not be additional.[30] The wind developers interviewed suggested that a retailer surcharge of approximately $10-$20 per MWh would need to be added onto these prices. The closer that the demand profile of the end user matches the generation profile of the wind farm, the less the retailer is exposed to risk from buying or selling surplus electricity units on the spot market, and therefore the greater the bargaining position of the large energy user to negotiate a lower retailer charge.

Figure 21: Estimated electricity price of urban-regional wind PPA compared to alternatives (2013 prices)



	Grid Electricity (No carbon price)	Grid Electricity ($23/t carbon price)	Urban-regional wind PPA	100% Greenpower (No carbon price)	100% Greenpower ($23/t carbon
Total electricity price	21.9	24.1	26.0	26.3	28.5
GST	2.0	2.2	2.4	2.4	2.6
AEMO Charges	0.1	0.1	0.1	0.1	0.1
RET and ESS	1.3	1.3	1.3	1.3	1.3
Carbon price	0.0	2.0	0.0	0.0	2.0
Network charges	11.1	11.1	11.1	11.1	11.1
Energy charge	7.4	7.4	11.2	11.4	11.4

Assumptions: Energy charges are based on $90/MWh PPA plus losses + $15/MWh retailer surcharge. 100% Greenpower charged at $37/MWh (Pers. Comm. Climate Friendly, 2013)

Figure 21 above shows the impact on per kWh peak ToU electricity prices for a large commercial customer. The per kWh charges for grid electricity were obtained through billing analysis of 2013 prices faced by council depot, administration building and aquatic facilities of three of the eight participating SSROC councils and represent the average per kWh price. Network charges are identical in all scenarios and we have assumed that other charges to account for AEMO and green schemes are constant across all pricing scenarios despite the fact they can be negotiated with the retailer.

As can be seen above, the urban-regional wind PPA is slightly more expensive than purchasing grid electricity, but cheaper than purchasing 100% Greenpower, although it would involve more Council

[29] The authors interviewed representatives from both a large wind developer and a small wind developer
[30] City of Sydney, in order to ensure their emissions reduction activities had an additional impact to Australia's 20% renewable energy target by 2020, did not surrender the STC's (Small-scale trading certificates) associated with their solar PV installation at Town Hall.

human resources to establish. A $23 carbon price makes the urban-regional wind PPA peak ToU price almost the equivalent price to grid fired electricity, coming at a surcharge of only 1.9c/kWh. As the PPA reduces electricity emissions by 100%, this equates to an emission abatement cost of only $21/t CO_2e assuming that NSW grid emissions are 0.886t CO_2e/MWh (DIICC, 2013). If the carbon price is removed, the additional cost of the PPA increases from 1.9c/kWh to 4.1c/kWh, which equates to an emissions abatement cost of $46/tonne.[31]

Table 12 and Table 13 below show the impact of the urban-regional wind PPA versus the alternatives of grid electricity and 100% Greenpower, with and without a carbon price. As can be seen, both the PPA and Greenpower options are relatively less competitive with the off-peak tariff.

Table 12: Estimated electricity prices (Peak, Shoulder and Off-Peak) – $23/t carbon price

	Peak	Shoulder	Off-Peak	Emissions change
BAU - Coal fired power	24.1	18.4	9.4	0
PPA with wind farm	26.0	20.3	16.8	
% change (relative to BAU)	8%	10%	79%	-100%
100% Greenpower	28.5	22.8	13.8	
% change (relative to BAU)	18%	24%	47%	-100%

Table 13: Estimated electricity prices (Peak, Shoulder and Off-Peak) – No carbon price

	Peak	Shoulder	Off-Peak	Emissions change
BAU - Coal fired power	21.9	16.2	9.4	0
PPA with wind farm	26.0	20.3	16.8	
% change (relative to BAU)	19%	26%	79%	-100%
100% Greenpower	26.3	20.6	13.8	
% change (relative to BAU)	20%	27%	47%	-100%

Council role

Council as a direct renewable energy purchaser via a PPA

If council were to pursue this option, it would entail signing a PPA and renegotiating its energy contract for at least part of the project's operations. This would be most beneficial if a council wishes to have a direct relationship with a wind-farm. This is more likely to be the case when the council has a participatory role in a wind-farm project – for example, if the council is a member of a consortium or community group that invests in the wind farm (Option 3 outlined above). By doing so, the council could cross-subsidise a proportion of the additional electricity charges associated with the PPA by ongoing dividends from the same wind-farm. This would enable the council to go 100% renewable at lower cost.

[31] At the time of writing it was highly likely that the carbon pricing legislation would either be repealed entirely, or the existing $24.5/t carbon price would fall substantially through a policy decision to link with European carbon markets.

Council as a facilitator for large energy businesses to purchase electricity via PPA
If council were doing a direct renewable energy PPA, there may be scope to also facilitate large energy users in their LGA to participate in such an arrangement.

Recommended next steps

Initiate discussions with wind developers and community wind projects
SSROC should enter into preliminary discussions with wind-developers, community wind projects and a brokering retailer (if necessary) about an urban-regional partnership. Specifically, such discussions should to scope investment potential and prices and contract lengths for a wind PPA. This could also be done in combination with other interested councils.

Develop a compelling case and associated promotion materials for a council-led wind urban regional partnership
If preliminary discussions yield positive results, SSROC should create a compelling case for businesses to join and scope potential interested businesses. This would include creating a register of interest and information materials.

6.4 BIOENERGY – COUNCIL PARTNERSHIP WITH AN ENERGY COMPANY

Technology: *Bioenergy – Anaerobic Digestion of Food waste*
Delivery model: *Council residential food waste collection and delivery to a private (energy/waste company) owned and operated facility*

Description

Food waste anaerobic digestion is both a bioenergy generation and waste management strategy and thus for councils interested in progressing renewable energy, offers the opportunity to address two environmental priorities concurrently.

The model selected through the prioritisation process is a council partnership with an energy company; this model as described in Appendix D entails council either developing an entity part owned by council, part owned by a council or group of councils or council entering into a build and operate contract with an energy company. However, because bioenergy using food waste has different characteristics to energy only projects such as solar PV or trigeneration, the model is slightly different.

The model more closely reflects a waste collection model rather than an energy model – council collects the food waste or contracts to a specific company to do so, and delivers the food waste to the bioenergy facility and pays a gate fee (instead of a landfill levy) per tonne of resource. However, the difference between a landfill or an alternative waste treatment facility is that all of the methane from anaerobic digestion of food waste (a greenhouse gas 25 times more potent than carbon dioxide)[32] can be used to generate renewable electricity and fertilizer that can be used for agricultural purposes is also created. In the case of landfill it is estimated that 70% of methane produced is captured to generate electricity at most Sydney landfills. Thus using an anaerobic digester would increase this proportion to 100%, as well as create a productive fertilizer stream, reduce leachate runoff, and reduce space pressures on landfills.

[32] http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf

In Sydney, there is already a food waste anaerobic digestion facility in operation (Earthpower) that is not yet at capacity. As such, this combination option considers the viability and options for residential food waste bioenergy using a current facility. The economics of commercial food waste collection is not examined, as it is not the remit of councils. However, councils could play an advocacy and education role with respect to commercial food waste anaerobic digestion.

Host site: Dedicated renewable energy/waste processing facility
Who owns the system: Food waste processing company
Who develops the project: Food waste processing company (energy generation); councils (collection)

Financing flows

A bioenergy facility is paid to take food waste as a waste resource. The gate fee for residential waste is paid by council, then is passed on through a waste levy included in council residential rates. The gate fee will be set by the bioenergy facility to cover the costs of operation, debt repayment as well as a profit. The bioenergy facility is also paid by an electricity retailer (likely through a power purchase agreement) for the sale of electricity that is generated above what is used on site.

Economic evaluation of bioenergy

Given that food waste anaerobic digestion more closely resembles a waste option, its economic viability is more dependent on its comparison to other waste management options than to other energy (renewable or non-renewable) options. ISF has undertaken an economic evaluation of this option from three perspectives – council, a bioenergy facility and society (overall). The information used draws heavily from Leichardt Council's existing food waste collection program for multi-unit dwellings and Earthpower, the existing bioenergy generation facility.

Table 14 provides a cost benefit analysis of a food waste anaerobic digestion system that generates 6667MWh of electricity per year (net), is rated at 2.12MWe and processes 30,291 tonnes of food waste. The cost benefit analysis is based on the assumptions outlined in Table 15. Three scenarios based on low, medium and high kerbside collection costs are given due to the wide-ranging data received. Note negative figures indicate costs (outlay) while positive figures indicate benefits (income).

Table 14: Food Waste Anaerobic Digestion Cost Benefit

	Low kerbside collection cost	**Medium kerbside collection cost**	**High kerbside collection cost**
Council Costs			
Collection System Upfront costs ($/HH)	-$46	-$46	-$46
Collection System Soft Costs ($/HH/yr)	-$12	-$12	-$12
Collection System Hard Costs ($/HH/yr)	-$22	-$52	-$73
Gate Price ($/t)	-$180	-$180	-$180
Total Cost ($/yr)	-$16,619,061	-$25,302,900	-$31,364,104
Total Cost ($/MWh)	-$2,494	-$3,797	-$4,706
Council Benefits			
Avoided Landfill cost ($/yr)	$727		
Avoided greenhouse emissions ($/MWh)	$ 27		

Council Waste Levy	Not included		
Total Benefit ($/yr)	$5,028,872		
Total Benefit ($/MWh)	$755		
Council Cost/Benefit ($/yr)	-$21,647,934	-$30,331,773	-$36,392,976
Council Cost/Benefit ($/MWh)	-$3,248	-$4,552	-$5,461
Bioenergy Facility Costs			
Capital Cost ($/MW)	-$14,000,000		
Fixed Operation and Maintenance Costs ($/MW/yr)	-$1,400,000		
Bioenergy Facility Benefits			
Food Waste Income ($/t)	$ 180		
LGCs ($/MWh)	$ 35		
Generation Revenue ($/MWh)	$60		
Fertilizer ($/MWh)	Not quantified		
Bioenergy Facility Cost/Benefit ($/MWh)	$26		
Societal Costs			
Collection System Upfront costs ($/HH)	-$46	-$46	-$46
Collection System Soft Costs ($/HH/yr)	-$12	-$12	-$12
Collection System Hard Costs ($/HH/yr)	-$22	-$52	-$73
Capital Cost ($/MW)	-$14,000,000		
Fixed Operation and Maintenance Costs ($/MW/yr)	-$1,400,000		
Societal Benefits			
Avoided Landfill cost ($/MWh)	$4,846,631		
LGCs ($/MWh)	$35		
Fertilizer ($/MWh)	Not quantified		
Generation Revenue ($/MWh)	$60		
Avoided greenhouse emissions ($/MWh)	$27		
Societal Cost/Benefit ($/MWh)	-$1,710	-$3,000	-$3,930

Table 15: Food Waste Anaerobic Digestion cost benefit assumptions

Assumptions		**Source**
Number of households	291,404	SSROC, 2012
Food Waste (kg/HH/yr)	315	OEH Love Food, Hate Waste

Food waste recovery rate (%)	33%	Hyder, 2012a
Food waste to energy conversion factor (kWh/t)	220	Moriarty, 2013, p31
Lifetime of Bins (yrs)	10	ISF Assumption
Low kerbside Lift Cost	0.4	Based on Leichardt Council Information
Medium kerbside Lift Cost	1	Hyder, 2012b (residual bin lift)
High kerbside Lift Cost	1.4	Hyder, 2012b (organics bin lift)
Landfill Gate Price ($/t)	160	Hyder, 2012b ($95 gate fee, $65 operating fee)
Lifetime of Bioenergy Plant (yrs)	20	Talent with Energy (2013, p107)
Bioenergy Facility O&M costs (% of Capital Cost)	10%	ISF Assumption
Cost of Greenhouse Emissions ($/tCO2e)	24.15	2013-14 Carbon Price
Food Waste Greenhouse Gas Emissions Factor	0.02	DIICC, 2013
Avoided Landfill Gas Emissions (%)	30%	Hyder pers. Coms., assumes 70% of landfill gas captured and combusted at Sydney Landfills

This analysis, based on the assumptions shown in table 2, finds that anaerobic digestion of food waste from an SSROC council perspective is very expensive both as a waste collection system (an additional $21.6-$34.3m per year) and on an energy basis (a cost of $3,248-$5,461/MWh, which compares to a residential retail electricity cost of approximately $270/MWh). While the figures stack up for the bioenergy facility to make a small profit on an energy basis ($26/MWh), when these costs and benefits are combined and the transaction fee (gate fee/food waste income - $180t) is removed on an economic basis the cost benefit currently looks unfavourable from a societal perspective ($1,710-$3,930/MWh). However, there are several important wider factors that carry societal value, but have not been quantified in this analysis, as discussed below under Important Considerations.

Key considerations

How food waste anaerobic digestion compares to other food waste management options

For source-separated food waste or when it is comingled with garden organics, anaerobic digestion competes with composting (both backyard and commercial) and thermal treatment as organic resource recovery options. With low levels of feedstock contamination, all will produce fertilizer/compost, but anaerobic digestion and thermal treatment (e.g. pyrolysis) will also produce energy, while if not done well composting can release fugitive methane emissions that have a greenhouse impact. A cost comparison of these three technologies has not been undertaken, however, literature and the market environment indicate anaerobic digestion is a more expensive technology option.

Food waste otherwise is disposed of as comingled MSW, either to an Alternative Waste Treatment Plant, landfill or in the future perhaps an energy from waste facility. Each of these waste management options has environmental and economic costs and benefits, only some of which can be monetized. In particular the lack of landfill space in Sydney, indicates the need to investigate alternative options. As such, the cost/benefit analysis of food waste anaerobic digestion should be positioned in a wider lifecycle costing comparison with other waste management. Nevertheless, as a renewable energy option (as opposed to a waste management option) anaerobic digestion of food waste is significantly more expensive to society than the other renewable energy options considered. Therefore this option needs to be considered from the perspective of addressing waste and energy issues concurrently.

Waste Contracts
If participating councils were interested to proceed with residential collection of food waste for bioenergy, the issue of ongoing waste contracts would need to be resolved. It is likely that food waste collection would not be legally possible until existing contracts expire, which for many councils is several years away.

Education campaign
To make residential food waste anaerobic digestion a viable renewable energy option, one of the key elements is an extensive public education campaign. As a new waste management option, that will require behaviour change on a daily basis from households in order to increase uptake rates, council will have a significant education role to play.

Existing facility
As there is already an operating bioenergy facility in Sydney which is not yet at capacity, careful consideration of the economics and sunk resources should be given in any wider comparison of bioenergy, waste management and particularly food waste management options.

Recommended next steps

Conduct a lifecycle analysis and cost comparison of waste management options
It is recommended that SSROC as part of its Waste Management Strategy conduct a lifecycle analysis of the range of residential waste management options including anaerobic digestion of food waste. This analysis in addition to labour and capital costs, should take into account fugitive emissions, land availability, energy and nutrient recovery and more.

Investigate how to increase diversion of commercial food waste
It is recommended that participating councils explore their local opportunities to increase the level of diversion of food waste to an anaerobic digestion facility from businesses in their LGA.

6.5 SOLAR HOT WATER ON COUNCIL POOLS

Technology: *Solar hot water*
Delivery model: *Council Ownership*

Description

The installation of solar hot water on council pool sites is expected to provide councils with a highly cost-effective opportunity to reduce emissions from councils' own facilities. Councils would be well placed to approach this opportunity from a regional perspective through a bulk purchasing arrangement. It is anticipated that councils have sufficient knowledge of their existing systems to put out a competitive Request for Tender, or obtain a series of invited quotations, to design and install solar pool heating across the range of potential pool sites considering facility upgrades. It is anticipated that there are a sufficient number of promising opportunities to warrant an advertised competitive RFT process.

Such a project would provide councils with the opportunity to demonstrate leadership to the community. The project could act as a demonstration site to demonstrate the opportunities associated with renewable energy to community members.

Host site: Council pools – roof sites for indoor pools and aquatic centres

Who owns the system: Council
Who develops the project: Council

Financing flows and benefits

The financial flows in this model are very straight forward. Councils would fund the purchase and installation of the solar hot water system, and be responsible for the costs associated with ongoing maintenance and operation of the system. Councils would benefit from the system due to savings on electricity/gas bills associated with these sites.

Economic evaluation of solar pool heating

Detailed economic analysis was not undertaken as this option was not prioritised as part of the workshop process. However, ISF experience with other councils is that solar water heating is likely to deliver sufficiently substantial savings at a relatively moderate capital investment, to achieve simple payback times in the order of 3-5 years. However, the business case will likely be highly dependent on the characteristics of the particular site with respect to the type and life stage of the plant being replaced or supplemented, proximity of available area for solar collectors, and the hours of operation of the facility. These pieces of information should be collected for the Request for Tender, as discussed below.

Recommended next steps

Prepare a request for tender for solar hot water for pools:
Councils should nominate a coordinating agent within one of the member councils to collect the basic information required to prepare a Request for Tender or obtain quotations. The types of information required will be a prioritised list of sites including technical and life stage details of current water heating plant to be replaced or supplemented, plans of available space for pool heating equipment, etc. Identify funding sources and confirm investment payback criteria for assessment.

Having laid out the technology and delivery models, the following chapter outlines the key enabling actions that can be undertaken by the Councils to support their delivery and use.

7 ENABLING ACTIONS

This section outlines the key enabling actions that councils should pursue to assist in the implementation of options under the Renewable Energy Master Plan thereby working towards increasing the generation and use of regional and local renewable energy. These actions were selected based on ISF expertise and synthesising suggestions identified in workshops as being ways councils could support stakeholders to increase the uptake of renewable energy.

In no particular order, it is strongly recommended that councils:

1. Continue with the current regional approach to renewable energy planning;
2. Provide information and resources to assist business and the community in understanding the opportunities related to renewable energy;
3. Adapt planning regulations to ensure renewable energy is facilitated and encouraged (and perhaps required) by development controls;
4. Engage with the local distribution network service provider (DNSP);
5. Lobby state and federal government for regulatory reforms, especially relating to grid connection;
6. Undertake feasibility studies and demonstration projects to identify key challenges and demonstrate opportunities to the community;
7. Consider establishing an energy service organisation; and
8. Consider establishing a revolving loan fund.

Each of these recommendations is now considered in more detail.

7.1 CONTINUE WITH A REGIONAL APPROACH

Outputs from the workshops indicated that the community is satisfied with the regional approach that is currently being undertaken. The regional approach, which has involved eight councils within the southern Sydney region collaborating to work towards the development of this Renewable Energy Master Plan, provides councils with a strengthened approach by presenting a united front and a consistent message to stakeholders.

A continued regional approach will:

- Allow for a consistent approach to communicating with community members;
- Provide councils with pooled resources for investigating and implementing projects;
- Add weight to lobbying and advocacy efforts; and
- Provide increased purchasing power for bulk buy agreements.

Community members also noted that they find it ‘reassuring’ to see councils working together on projects such as this. It is expected that the increased lobbying and buying power that is likely to result from a united approach will be invaluable for councils.

7.2 PROVIDE INFORMATION AND RESOURCES

A key action identified through the workshops is for councils to provide information to community members and businesses on renewable energy to facilitate informed decision making on this issue. Two key components to be considered for inclusion in education and engagement programs are:

1. Information contributing to greater energy literacy; and
2. Information about renewable energy installation and generation.

Energy literacy

Energy literacy refers to consumers' understanding of various concepts relating to energy. This includes relevant units, including differentiating 'power' (kW) from 'energy' (kWh), and understanding how much a unit of energy costs, as well as how much power is consumed by various appliances.

Darby (2006) notes that most people have only a vague idea of how much energy they are using and for what purposes, and what sort of impact various energy efficiency measures could have upon their consumption. Focusing on the Australian context, a recent article by News Ltd (2013) reports that, generally, Australians have a low level of energy literacy, with most unable to identify large energy users or effective energy saving measures. This indicates a need for consumers to be provided with more useful information to assist them in making informed decisions about their energy consumption.

Councils have an opportunity to help people understand their energy consumption and what could be done to reduce it. Education and engagement programs that aim to improve energy literacy should be considered for both community members and businesses. Improved billing and enhanced feedback regarding energy consumption are possible methods for helping the community understand their energy consumption.

This may involve setting up dedicated energy-literacy education programs to engage the community on energy-related issues and improve their awareness and knowledge of such issues. Alternatively, it could involve ensuring that consideration is given to energy literacy through existing engagement programs. Most councils run community workshops on sustainability and energy efficiency – ensuring that these give due consideration to outlining the ‘basics’ and improving the community’s energy literacy will likely improve the impact of these programs.

Renewable energy

Feedback from workshops with community and businesses indicated a desire for improved and detailed information and resources about renewable energy. Presently, a lot of the information available about renewable energy is provided by companies who sell and manufacture the systems, and thus may not be impartial or unbiased. Consumers need impartial information in order to make informed decisions about their investments in renewable energy. Community members could benefit from councils providing information about renewable energy technology, financing for renewable energy systems, payback periods, grid connection and other network issues, and other relevant information about renewable energy installations.

Regular, relevant information provided by a trusted source such as local government would be extremely useful for community members in allowing them to make informed decisions and wise investments. Councils may consider including such information in current communications with community members, or set up dedicated engagement or communication programs related to renewable energy. Setting up a dedicated energy service organisation to provide information and advice to community members, such as the Moreland Energy Foundation, is an excellent way of achieving this goal. More detail is provided on this option in Section 7.7 below.

7.3 ADAPT PLANNING REGULATIONS

Local governments should undertake reviews and, if necessary, make amendments to planning regulations to ensure that they facilitate and encourage the uptake and installation of renewable energy. Councils could do this in two ways:

1. Ensure that development controls facilitate the installation of renewable energy systems on new and existing sites; and
2. Set renewable energy targets for all new developments to complement greenhouse gas reduction targets underpinning BASIX compliance.

The first of these refers to ensuring that there are no provisions in development control plans or other relevant planning policies that would hinder or prohibit the installation of renewable energy systems on appropriate developments. This could involve ensuring that control plans include guidance for managing renewable installations with heritage concerns, that they give due consideration to the impacts of new developments upon existing solar PV or hot water systems (avoiding overshadowing, etc.) and that they are designed to make integration of renewable generation a simple process for developers.

The second aspect refers to setting targets for renewable energy generation for new developments. This was first undertaken by Merton Council in the UK in 2003 – and is now commonly referred to as the 'Merton Rule'. Merton Council adopted a planning control, which specified that all new developments over a certain size (10 housing units or 1,000m^2 of non-residential development) must source at least 10% of their energy from an on-site renewable system. Compliance is required as a condition of consent, and requirements are calculated using national energy consumption benchmarks.

This requirement also encourages developers to undertake energy efficiency actions to ensure that their footprint is reduced, thus reducing the cost of the renewable energy installation. Merton Council will be increasing the renewable energy requirement to 20% in 2013, and are considering expanding it to include new developments of all sizes.

Mechanisms such as this allow integration of renewable systems into building design, and actively encourage both energy efficiency and renewable energy uptake. Councils should consider opportunities to include this in relevant planning controls to facilitate widespread uptake of renewable energy systems in all new developments.

7.4 ENGAGE THE ELECTRICITY NETWORK BUSINESS

In order to significantly increase the uptake of local renewable energy generation, it will be essential for SSROC to engage with the local distribution network service provider (DNSP) – Ausgrid. Local renewable energy generation can result in either reduced or increased costs to the distribution network, depending on a range of technical factors. As such, involving the network business specifically in the development of both a commercial and residential solar PV program is recommended in order to look for opportunities to geographically target areas with high correlation between energy demand and the timing of solar PV power generation.

7.5 ADVOCATE FOR REGULATORY REFORMS

Changes are needed at a state and federal policy level to incentivise renewable energy and remove some of the existing barriers to widespread uptake. It is recommended that SSROC councils lobby for changes in relation to:

1. Pricing stability – a consistent and fair policy on the value obtained for exported energy, such as through the pursuit of 'virtual net metering' or meter aggregation; and
2. Grid connection fees for renewable energy generators.

Pricing Stability

Ongoing uncertainty surrounds the pricing of renewable energy in Australia. Changes to NSW state policy have created instability, and a reduced feed-in tariff for solar PV minimises the incentive for households to install PV systems. Councils should lobby for a higher feed-in tariff that recognises the locational value of distributed generators within the electricity network.

One means of achieving this goal is through 'virtual net metering' (VNM), whereby the exported energy from a net metered distributed generator, such as a solar PV system, could be assigned to another metered site within a certain geographical or network proximity. This form of virtual net metering is classified as 'Single Entity VNM' by ISF researchers in their recent discussion paper on this topic (Langham et al, 2013) and has been referred to as meter aggregation overseas. Virtual net metering in this form is already permitted for local government participation in at least ten US states; however there are no known applications in Australia that involve a lower charge for use the electricity network, thus limiting the value that can be obtained by the generator.

Whilst longer-term regulatory reforms are likely to be required to make virtual net metering a mainstream proposition, there may be opportunities for a council or council representative body such as SSROC may have a more direct and immediate effect by convincing the local distribution network service provider (DNSP) to undertake a trial of single entity virtual net metering across a number of metered sites. For example, a council that owns multiple metered sites could install a large rooftop or ground mounted solar array on one of its sites with the primary aim being to not only offset energy demand at the site of installation, but also at other nearby sites. This would mean that the council would not need to always match a solar PV array with on-site building demand, which may open up a greater number of viable roof spaces.

Other forms of virtual net metering would allow investors in a community renewable energy facility to have the electricity credited directly to their bill which would eliminate the need for a 'behind the meter' PPA and therefore open up many more potential sites for renewable energy development. For more information on the potential of virtual net metering, please refer to Langham et al. (2013).

Grid Connection Fees

Uncertainty regarding the costs and information for connecting to electricity and gas networks is a significant barrier to adoption of renewable energy systems. It is recommended that councils lobby for regulatory reform to ensure that renewable energy generators can access the necessary information and expect consistent, standardised costs for grid connection to remove some of the uncertainty associated with the costs of renewable energy generation.

7.6 UNDERTAKE FEASIBILITY STUDIES AND DEMONSTRATION PROJECTS

Councils should undertake feasibility studies and continue with demonstration projects for renewable energy generation. Demonstration projects provide:

- **Opportunities to demonstrate leadership to the community** – councils will be seen as leading by example and demonstrating a serious commitment to reducing the carbon footprint of the local area;
- **Increased understanding of the potential barriers and opportunities** relating to renewable energy, especially those which may be particular to the local area and may not be covered by more general studies or literature;

- **Opportunities to show the community what is possible** with regard to renewable energy installations, and to allow them to seek first-hand advice and experience from council staff who have overseen the implementation;
- **Increase energy independence** and hedge against future energy price rises through installing local renewable energy generation**;** and
- **Reductions to councils' energy bills and carbon footprints**, advancing towards their financial sustainability and commitments to reduce their environmental impact.

7.7 CONSIDER ESTABLISHING AN ENERGY SERVICE ORGANISATION

Councils should consider establishing an energy service organisation to assist their community members in managing the transition towards a clean energy future. An energy service organisation can provide the community with advice and consultancy services, as well as provide education and communication programs on energy. Key activities of an energy service organisation might include:

- Research on key energy issues to inform policy, advocacy and education;
- Consultancy to assist community members in decision-making about energy efficiency and renewable energy, somewhat resembling the function of an Energy Services Company (ESCO);
- Advocacy for policy change at state and federal levels;
- Comparisons of retailers and products to provide consumers with information to assist decision making;
- Advice on available rebates and funding;
- Training for community members, tradespeople and other service providers; and
- Implementation of energy efficiency and renewable energy programs, including conducting home audits and providing energy efficiency kits.

The Moreland Energy Foundation (http://www.mefl.com.au) provides an excellent Australian example of an energy service organisation, which can be considered a form of social enterprise. Moreland focuses on community-based renewable energy solutions and capacity building including building partnerships and alliances with stakeholders and the local community, sharing energy knowledge and providing leadership. With base-funding from Moreland Council, Moreland Energy Foundation tops up its funding by charging fees for training and consultancy services.

Using the extensive experience gained from working in a range of regional partnerships (such as for the Cooks River Alliance) the SSROC councils should consider establishing a regional energy service organisation to provide information and other services to the community to assist them in understanding energy consumption and making informed decisions about energy efficiency and renewable energy.

7.8 CONSIDER ESTABLISHING A REVOLVING LOAN FUND

Revolving loan funds are funds from which loans are made for particular purposes, and to which any repayments, fees and interest is returned to the pool to support additional loans.

A revolving loan fund for renewable energy could be used to help community members pay for the installation of renewable energy systems. Repayments (including fees and interest) are then made to the fund, which is used to make further loans.

Revolving loan funds for energy efficiency and renewable energy have become very common both in Australia and the US. In the US, a federal program encouraging states to administer revolving loan funds for energy projects having delivered millions of dollars in loans. For more information on the successes of the US program, see http://www.cleanenergystates.org/assets/Uploads/Resources-post-8-16/staterevolvingloanprograms.pdf.

Private organisations such as universities have also established revolving loan funds. Harvard University established an $11.5 million revolving loan fund for its various departments to utilise to install energy projects. This fund delivered over $4 million in energy-cost savings, equivalent to a 27% return on investment (NREL, 2012).

In Australia, a number of councils such as Lismore and Hornsby have established revolving energy funds for council energy operations. This recommendation extends the idea of a council operation energy loan fund, to also potentially cover projects in the wider LGA. Further investigation of how to set up such a fund that is compliant and low risk, will be required. Councils would also need to identify a source of initial capital before making progress to establish a revolving loan fund. This might include council financial reserves, state or federal government grant funding, or a one-off levy on constituents. Councils would also need to consider eligibility criteria (with particular consideration for equity with regards to access to the funds), reporting, insurance and collateral requirements. The types of projects the funds could be used for and the length of the loan period would need to be scoped to ensure that funds are being effectively utilised and that they are delivering returns on investment.

8 CONCLUSION AND RECOMMENDATIONS

Based on the analysis of the eight priority options and additional research into enabling actions, the following recommendations are made to progress the uptake of renewable energy in the participating SSROC council areas and beyond:

5. Continue the existing **cross-council working party** with responsibility to scope and deliver the *Our Energy Future: Renewable Energy Master Plan*.

6. Prioritise, scope, seek funding for (where required) and deliver the following **recommendations** associated with the eight priority renewable energy delivery model combinations (Section 6, pages 39 - 66):
    a. Install appropriately sized solar PV on all viable council roofs, potentially through a bulk tendering process
    b. Provide information and materials to facilitate commercial solar PV deployment
    c. Create a trusted list of commercial solar PV developers
    d. Develop a council residential solar PV brokering (bulk-buy) program covering both upfront purchase and leasing/PPA options
    e. Initiate discussions with wind developers and community wind projects about a wind urban-regional partnership
    f. Develop a compelling case and associated promotion materials for a council-led wind urban regional partnership
    g. Conduct a lifecycle analysis and cost comparison of waste management options including anaerobic digestion of food waste
    h. Investigate how to increase diversion of commercial food waste to anaerobic digestion
    i. Prepare a request for tender for solar hot water for community pools in the SSROC area

7. Employ the following **enabling actions** that will assist with implementing the priority renewable energy technology and delivery models (Section 7, pages 68 - 74):
    a. Continue with the current regional approach to renewable energy planning
    b. Provide information and resources to assist business and the community in understanding the opportunities related to renewable energy
    c. Adapt planning regulations to ensure renewable energy is facilitated and encouraged (and perhaps required) by development controls
    d. Engage with the electricity network business - Ausgrid regarding deployment promotion plans, particularly in the context of high penetrations of solar PV
    e. Lobby state and federal government for regulatory reforms, especially relating to a fair price for renewable energy export and connecting renewable energy to the electricity grid
    f. Undertake feasibility studies and demonstration projects to identify and resolve key challenges (such as grid connection, proving new business models, etc.) and demonstrate opportunities to the community
    g. Consider establishing an energy service organisation
    h. Consider establishing a revolving loan fund

8. Explore the following additional **longer-term actions**:
    a. Investigate the viability, costs and benefits of advanced gasification as both a waste and energy management option for Southern Sydney as part of the SSROC Waste Strategy
    b. Investigate niche applications of ground source heat pumps or deeper geothermal wells as part of council or large energy user renewable heating and cooling options

c. In 3-5 years revisit the technical and commercial viability of ocean renewable energy options (wave and tidal) and energy storage
d. Once the recommendations are in train, SSROC should explore the potential to pursue other (non-prioritised) renewable energy, delivery model combinations identified in this report

The SSROC Councils, through the Our Energy Future process, have the opportunity to capitalise on a wealth of enthusiasm within their residential and business communities for new, low carbon local energy options. This Master Plan identifies a comprehensive range of priority next steps that will provide both quick wins and longer term leadership to increase renewable energy uptake in the participating council areas.

APPENDICES

A. ENERGY SITUATION ANALYSIS

See Energy Situation Analysis PowerPoint accompanying this document.

B. TECHNICAL ANALYSIS

This section outlines the methodologies used to calculate the technical energy generating potential of the selected renewable energy technologies and then presents an expanded discussion of the technical potential results.

B.1 SOLAR PV

The technical potential for solar PV was investigated for both residential and non-residential sectors across the eight councils.

B.1.1 Residential Solar PV Methodology

The methodology applied to estimate residential solar PV technical potential in the 8 participating LGA areas follows a similar method to that employed by Rae et al. (2009) to estimate technical potential of residential solar PV in greater Sydney.

Using the number of dwellings (by dwelling type) for each LGA as a starting place, the total horizontal roof area by dwelling type was calculated by multiplying the number of eligible dwellings by the average horizontal roof area of each dwelling type. The average roof area data replicates that used by Rae et al (2009) originally from Mills (2001); namely:154m2 for detached dwellings, 110m2 for semi-detached single-story and 55m2 for semi-detached double-story dwellings.

However, whereas Rae et al. estimated only the technical potential of solar PV installed on northerly aspect roofs, ISF researchers have estimated the technical potential for three separate categories of residential solar PV installation. These categories are defined below:

- **Optimal solar PV:** includes eligible installations on sloping roofs with a NE to NW aspect
- **Sub-optimal solar PV:** includes eligible installations on sloping roofs with a W to NW and E to NE aspect
- **Flat roof solar PV:** includes eligible installations on flat roofs, whereby the systems are installed on mounted frames in a northerly aspect

To calculate the potential roof area available for each category, the aspect factor is applied to total amount of roof area available. To this, factors are applied to account for shading, surface obstructions (for example skylights and chimneys), insufficient structural integrity of roof, and the mismatch between roof shape and the solar panel array. After applying these factors, the horizontal roof area is converted to a roof surface area (based on average 25° slope for optimal and sub-optimal solar PV and 0° slope for flat roof solar PV), which is then converted from meters squared (m^2) to kilowatts (kW) using a conversion factor (C) to provide the technical capacity potential of solar PV for each category.

This methodology can also be described in algebraic form:

$$KW_t = D_n \, x \, D_a \, x \, A_f \, x \, S_f \, x \, O_f \, x \, I_f \, x \, F_f \, x \, P_f \div C$$

Where:

KW_t = technical potential of solar PV for the category
D_n = the total number of dwellings in the analysis
D_a = the 'dwelling area' i.e. the average horizontal roof area per dwelling

A_f = the 'aspect factor', i.e. the proportion of total horizontal roof area assigned to each category
S_f = The 'shading factor' i.e. the proportion of horizontal area free from shading
O_f = the 'obstruction factor' i.e. proportion of horizontal area free from obstructions
I_f = the 'roof integrity factor' i.e. proportion of horizontal roof area structurally capable of supporting a solar PV system
F_f = the 'fit factor' i.e. the average proportion of surface area that is used due to shape match
P_f = the 'pitch or slope factor' i.e. roof surface area ÷ roof horizontal area
C = the conversion from area to kW i.e. roof surface area per installed kW of PV system

The ISF analysis does not account for:

- solar PV potential on multi-unit dwellings, garages or sheds
- ground or pole mounted solar PV potential
- competing uses of roof space such as solar hot water
- non-technical factors such as tenure status and costs
- the solar PV "carrying capacity" of the network

Table 16: The input data used to calculate the technical potential

Variable	Data by category			Data Source
	Optimal PV category	Suboptimal PV category	Flat roof PV category	
Dwelling Number (D_n) *(sum of LGA's displayed)*	Detached: 127,815 Semi-detached (single): 19,730 Semi-detached (double): 21,547			ABS (2011)
Dwelling Area (D_a)	Detached: 154m^2 Semi-detached (single): 110m^2 Semi-detached (double): 55m^2			Mills (2001)
Aspect Factor (Af)	20%	20%	20%	ISF Estimate
Shading Factor (S_f)	80%	80%	80%	ISF Estimate
Obstruction Factor (O_f)	90%	90%	90%	ISF Estimate
Roof Integrity Factor (I_f)	95%	95%	95%	ISF Estimate
Fit Factor (F_f)	95%	95%	95%	ISF Estimate
Pitch Factor (P_f)	1.2	1.2	1	Europe-solar.de factsheet (2013)
Area to KW conversion Factor (C) (m^2/kW_p)	8	8	14	Europe-solar.de factsheet (2013)

To calculate the energy generation from each system, capacity factors of 16% for optimal and flat roofed solar PV were obtained from Rae et al. 2009. Suboptimal solar PV was assigned a capacity factor of 11%, based on ISF estimate.

B.1.2 Residential Solar PV Technical Potential

Using the estimated assumptions (see Section B.1.1 above), it was estimated that over 1.1 million kilowatts (kW) of residential PV could be installed from a pool of almost 170,000 detached and semi-detached dwellings across the eight councils (Table 17). This represents a forty-fold increase in capacity from approximately 27,000 kW installed on residential dwellings in early 2013 (Section 2.2.1).

Table 17: Technical potential of residential solar PV systems in SSROC

LGA	Technical capacity potential (kW)		Current residential penetration		Generation potential
	Optimal NE-NW roofs	All capacity potential*	kW installed	% of tech potential	MWh/yr generation
Ashfield Council	20,000	50,000	1,400	3%	60,000
Bankstown City Council	130,000	320,000	8,100	3%	400,000
City of Canada Bay	40,000	100,000	2,700	3%	130,000
City of Canterbury	80,000	200,000	5,600	3%	240,000
Kogarah City Council	40,000	100,000	3,100	3%	110,000
Leichhardt Council	30,000	80,000	1,200	2%	110,000
Marrickville Council	40,000	100,000	2,200	2%	130,000
Rockdale City Council	60,000	150,000	2,600	2%	180,000
SSROC	**450,000**	**1,110,000**	**26,900**	**2%**	**1,360,000**

* i.e. Optimal (North facing, unshaded systems), flat and sub-optimal (E or W) roofs

If the technical potential of 1,100 MW was reached this would result in an energy generation of an approximately 1.4TWh; that is generating far more than the combined energy consumption of detached and semi-detached dwellings, and offsetting approximately 75% of the combined residential energy consumption in the 8-council region.

It should be noted that there are substantial connection and grid integration challenges associated with this level of PV uptake. The penetration of solar PV modelled while technically possible from a space availability perspective, would far exceed the capacity of the current electricity network to take this level of generation.

B.1.3 Commercial Solar PV Methodology

A similar calculation methodology was used to determine commercial technical potential as in the residential sector; however it differed in the initial step of estimating the total commercial roof area in each LGA. LGA data on zone boundaries and area was converted to Google Earth Pro, whereby 'roof-to-zone density' was manually measured by tracing the outline of each building within three sample zones and comparing it to the total area of each zone. From this a categorisation a 'roof to zone density' was created based on the following densities:

Table 18: Roof-to-zone density category bands

'Roof-to-zone density' category	Corresponding 'Roof-to-zone density' i.e the proportion of roof area to zone area
Low	20%
Medium	35%
High	50%

Using these categorisations, roof-to-zone densities were estimated for each zone-type (industrial, business and/or mixed use) in each LGA based on visual observation. The roof-to-zone densities were multiplied by the zone area to estimate the total commercial and industrial horizontal roof area in each LGA. The researchers employed a simplifying assumption that all commercial and industrial roof area is flat, allowing aspect factor and pitch factor to be set to one (i.e. eliminated from the equation). This means that all solar PV is installed on a mounted frame with northerly aspect for all commercial and industrial buildings. Shading, obstruction and roof integrity factors were then applied for each zone type and divided by the m^2 to kW conversion factor to provide the estimated technical potential for solar PV in the commercial and industrial sector for each LGA.

This is in algebraic form below:

$$KW_t = Za \times RZ_d \times S_f \times O_f \times I_f \div C$$

Where:

Za is area of the zone
RZ_d is roof-to-zone density
S_f, O_f and I_f have the same definition as in the residential sector and are estimate based on zone-type.

Table 19: Variables by zone type

Variable	Zone type		
	Industrial	Business	Mixed use
S_f	95%	85%	85%
O_f	95%	85%	85%
I_f	90%	90%	90%
C	14	14	14

The ISF analysis does not account for:

- ground-mounted, pole-mounted or building integrated PV potential
- competing uses of roof space such as solar hot water
- non-technical factors such as tenure status and costs
- the solar PV "carrying capacity" of the network

To calculate the energy generation from each system, capacity factors of 16% for optimal and flat roofed solar PV were obtained from Rae et al. 2009.

B.1.4 Commercial and industrial Solar PV Technical Potential

Using the estimated assumptions (see Section B.1.3 above), it was calculated that over 350,000 kW of PV could be installed on the roofs of commercial and industrial buildings in the 8 participating LGAs.

Table 20: Commercial and industrial technical potential for solar PV (kW)

LGA	Technical capacity potential (kW)	Generation potential (MWh/yr)
Ashfield Council	10,000	11,200
Bankstown City Council	190,000	267,700
City of Canada Bay	20,000	25,200
City of Canterbury	40,000	49,100
Kogarah City Council	10,000	8,400
Leichhardt Council	10,000	18,200
Marrickville Council	60,000	82,700
Rockdale City Council	20,000	32,200
SSROC	**350,000**	**494,700**

If the technical potential of 0.5TWh is reached this would result in an energy generation that would offset over a quarter of the total commercial and industrial energy consumption in the region.

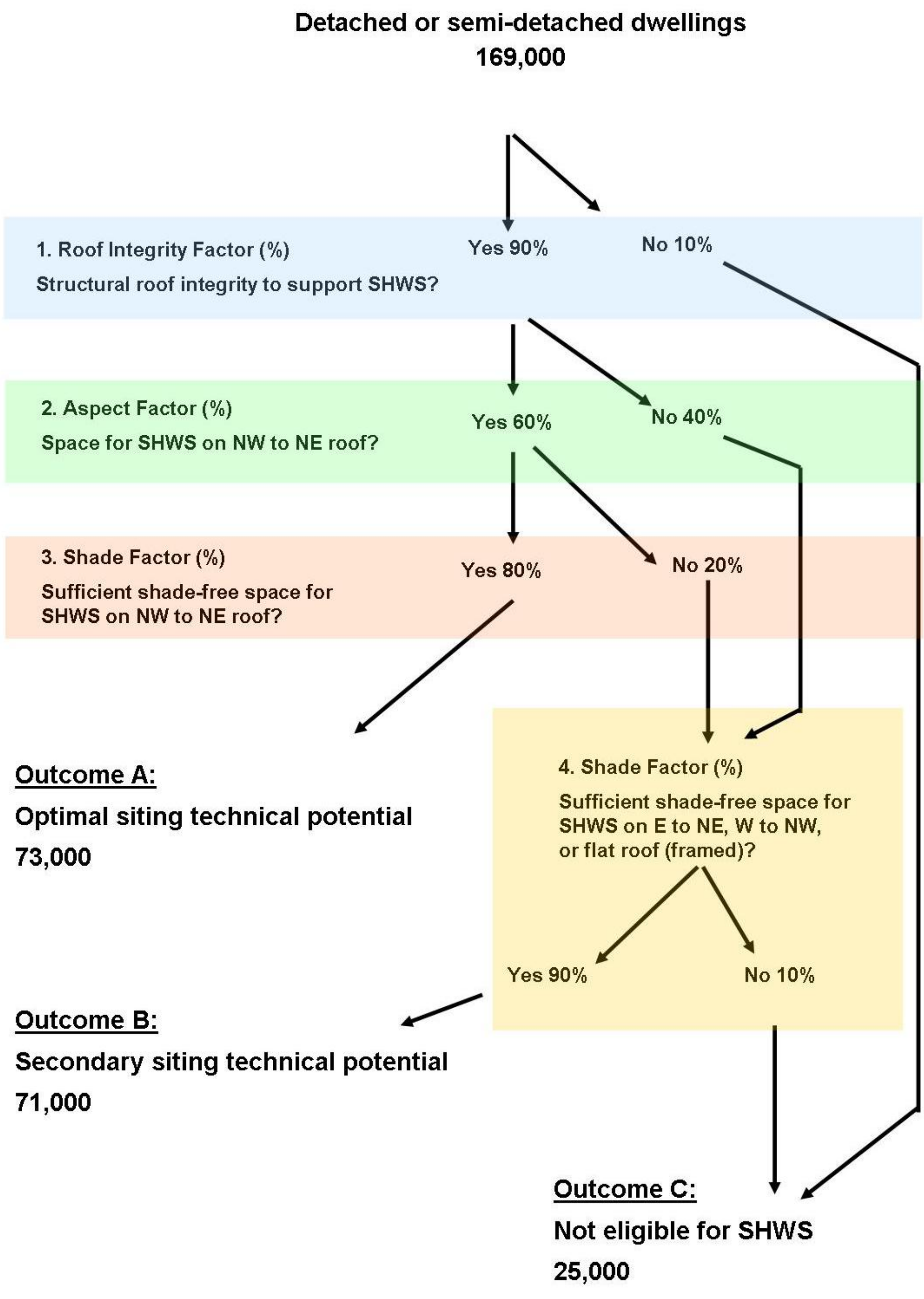
B.2 SOLAR HOT WATER

The technical potential was investigated for both residential and community pool solar hot water systems.

B.2.1 Methodology for Residential Solar Hot Water

The flow chart in Figure 22 describes the methodology for calculating the technical potential of residential solar hot water systems in the participating SSROC council areas.

Figure 22: Flow Chart description of methodology for residential solar hot water systems



We have assumed that each household is eligible for only one hot water system.[33] This means that the methodology for calculating the technical potential for residential hot water systems is able to follow a decision-tree style chart as shown in Figure 22.[34] From this methodology it is clear that households are suitable for optimal northerly facing solar hot water if they pass tests for structural eligibility, aspect and shading. If they fail either aspect or shading, then they are tested for shading on a non-optimal roof such as east, west or flat.

[33] Number of households is based on is ABS LGA profiles Census Data (2011)
[34] Energy savings are assumed to be 1500kWh/hh/yr based on IPART (2013)

These estimates do not account for:

- competing uses of roof space such as solar PV
- non-technical factors such as tenure status, heritage permissions and costs
- households having more than one HWS
- multi-unit dwellings

B.2.2 Residential solar hot water technical potential

Using the estimated assumptions (see Appendices), it was calculated that over 140,000 of the almost 170,000 residential households in the 8 surveyed LGAs have the technical potential for a solar hot water system.

Table 21: Residential technical potential for solar hot water

LGA	Technical potential (# Solar Hot Water Units)		Generation potential (GWh/yr)	Current saturation	
	Optimal roofs only	Optimal, flat and sub-optimal roofs		# Solar hot water systems installed	% of technical potential
Ashfield Council	3,000	7,000	9,848	272	4%
Bankstown City Council	21,000	42,000	62,710	2,303	6%
City of Canada Bay	7,000	14,000	20,635	455	3%
City of Canterbury	12,000	25,000	36,834	1,329	5%
Kogarah City Council	5,000	11,000	16,019	690	6%
Leichhardt Council	7,000	13,000	19,567	658	5%
Marrickville Council	8,000	16,000	23,415	547	4%
Rockdale City Council	9,000	18,000	27,375	601	3%
SSROC	**73,000**	**144,000**	**216,404**	**6,855**	**5%**

If the technical potential for residential solar hot water was reached this would result in energy savings of approximately 210,000MWh, assuming average energy savings are 1,500kWh/household/year (hh/yr) based on findings in IPART (2011). These savings would account for approximately a 20% reduction in the household energy consumption of those with solar hot water installed, and 11% of all residential energy consumption across the 8 LGAs in the analysis.

B.2.1 Community pools solar hot water methodology

This analysis investigated the potential of solar hot water at council community pools within the 8 LGAs. As no detailed energy data for all pool in the LGA was available, a basic thermal pool model was used to provide a approximation of the technical potential of the pool heating that could be displaced by solar, by determining the energy heating demands based on size and shape of pools, as well as operating criteria. The following information was assumed about different pools within the area:

- Volume and surface area (defaults: depth 2.2m, length 50m, number of lanes 8)
- Location (indoor/outdoor)
- Opening hours (defaults: summer 12 hrs and winter 9 hrs)
- Pool covers outside hours of operation (default: yes)
- Heating fuel source (electricity/gas/solar; default: gas)

- Pool heating thermostat settings (outdoor default: 24 degrees)
- Amount of fuel bill that could be displaced by solar (default: 70%)
- Pumping energy (assumption: not quantified as pumping energy assumed to be required in both solar and non solar cases)

Where actual information about each pool was known, this was used to override defaults, however defaults were used in the vast majority of cases.

The above figures were calculated for a total of 35 pools across the eight LGAs.

B.2.2 Community pools solar hot water technical potential

The technical potential to convert gas and electric pool systems to solar, with an average displacement of 70% is shown in Table 22 below.

Table 22: Technical potential of converting gas and electric pool heating to solar

Council Area	MWh/a
Ashfield Council	0
Bankstown City Council	5,900
City of Canada Bay	5,300
City of Canterbury	2,000
Kogarah City Council	4,400
Leichhardt Council	4,300
Marrickville Council	2,000
Rockdale City Council	6,600
SSROC	**30,500**

As limited actual pool data was available, the level of certainty over these results is low. If participating councils wish to pursue obtaining a greater understanding of this opportunity and impacts of energy savings measures such as pool covers, and further developing the solar pool heating model as a council resource, this could be pursued outside the scope of this Master Plan. However, it is anticipated that councils are likely to have sufficient understanding of the facilities and their parameters to be able to take this opportunity to competitive tender. See the recommendations section for further information.

B.3 WIND ENERGY

B.3.1 Wind Energy Technology Overview

Roof-mounted systems

Several manufacturers market wind systems as 'urban turbines', in that these turbines are smaller or quieter or require less wind speed to produce energy and are therefore better suited to urban environments. However, wind systems installed on roofs do not produce much electricity because of the slow wind speeds in urban areas or have short life spans because of the turbulence, and as a result are never economically sound (Encraft, 2009; Sagrillo, 2008). Be wary of turbine installers or manufacturers claiming products are suitable for urban or turbulent locations (Sagrillo, 2005). ISF strongly recommends that no roof-mounted wind energy systems are investigated in SSROC councils.

Utility-scale wind systems
Utility scale-wind energy is not appropriate in urban areas, however a viable option for SSROC to utilize this technology is to explore a partnership with a rural council or community for a joint investment in a large-scale utility wind system. This is a delivery model (with technically unlimited potential) and therefore this is discussed in more detail in Section 3.

Small-scale wind systems
Small-scale wind systems are defined as wind turbines with a 1-100kW capacity. To use wind technology, it is *critically* important to install turbines in open sites and on sufficiently tall towers. Sites must be open to ensure wind systems are placed out of turbulent wind areas and sufficient tower heights must be calculated and used to ensure the wind system accesses a wind speed sufficient to both move the blades and more importantly ensures the system operates to a level for which it was designed.

The amount of power that a wind system is able to produce is exponentially proportional to the speed of the wind. In addition wind systems require smooth, laminar wind, of a speed typically greater than 4 meters/second (m/s). To achieve these speeds and smoothness of wind, productive wind power systems require tall towers to place the wind generator in clean wind, well above areas of turbulence caused by obstructions. Urban areas have a poor wind resource that is usually extremely turbulent and finding appropriate wind energy sites is usually impossible in urban areas.

There are two common types of small wind systems, vertical axis and horizontal axis systems. Horizontal axis systems are usually 2 or 3 blade systems that have the same design as the large-scale utility systems. Vertical axis systems have a wide variety of designs, however will never reach the efficiency or production of a horizontal axis wind system (Sagrillo, 2005). Therefore, for this review, we have looked at the technical potential of a small (defined as between 1kW and 50kW) horizontal axis wind system in SSROC region.

B.3.2 Wind Energy Methodology

To calculate the technical potential for small wind, the minimum standards of performance for a small wind system were defined as:

- The site must have access to wind speeds greater than 4.5m/s.
- The site must have access to smooth laminar wind.
- The turbine must be tower mounted on the ground.
- The turbine will not be roof-mounted.
- The turbine will be horizontal axis, with 2-3 blades.

The methodology for scoping small wind systems within the eight councils was as follows:

1. Scope areas within the 8 councils that have access to wind speeds of at least 4.2 m/s at heights of 30 m or greater.

2. Investigate large, open spaces within the 8 council areas with council contacts and then using Google Earth or GIS maps.

    a. Sites must be clear, obstruction-free space, at least 300 m in diameter.
    b. Sites must be ideally 2km away from an airport.
    c. Site must have an energy demand within 300m of the potential wind system location.
    d. Site must meet the zoning requirements of the NSW Planning requirements for wind energy.

3. Calculate the average performance for a 5kW wind system and a 100kW wind system at each site, for the average wind speed at 40m and multiply by the number of sites.

B.3.2.1 Wind speed estimates

	Average wind speed (m/s) by source **[height of wind speed (m), resolution of map]**			Estimated wind speeds at turbine hub height	
Council and sites	**NSW Wind Atlas** [65m, 8km]	**Windlab (avg across council)** [80m, 3km]	**3-Tier** [80m, 5km]	**36m***	**40m***
Ashfield	3.6 – 6.6	5.8	5	4 m/s	4.1 m/s
Bankstown	3.6 – 6.6	5.8	5		
Canada Bay	3.6 – 6.6	5.8	5		
Canterbury	3.6 – 6.6	5.8	5		
Leichhart	3.6 – 6.6	5.8	5		
Marrickville	3.6 – 6.6	5.8	5		
Kogarah	3.8 – 7.2	5.8	5	4 m/s	4.2 m/s
Rockdale	4.1 – 7.6	6	5-6	4.3 m/s	4.4 m/s

*Assuming a wind sheer of 0.40

What this analysis demonstrates is that the wind resource in the SSROC is very poor and if small wind systems were to be pursued, the tallest towers on the market would be necessary.

However, for the purposes of comparison to other technologies, two sites were found. These sites were identified using Google Earth / GIS maps and with guidance from council team members with respect to obstruction free areas that have a diameter of at least 300m.

The two councils where a small wind system may be appropriate are Kogarah and Rockdale, due to their proximity to the water and slightly higher wind speeds relative to the high density areas of the land-locked councils. Three illustrative locations have been identified and are pictured and summarised below against key criteria.

Kogarah: Carss Park Olympic Pool

Rockdale: Dolls Point

Table 23: Summary of illustrative small wind energy system locations against criteria

Criteria	Kogarah: Carss Park Olympic Pool	Rockdale: Dolls Point
Sites must be clear, obstruction-free space, at least 300 m in diameter.	280m (E/W) x 200m (N/W)	75m (E/W) x 100m (N/W)
Sites must be ideally 2km away from an airport.		
Site must have an energy demand within 300m of the potential wind system location.	Yes	Yes
Site must meet the zoning requirements of the NSW Planning requirements for wind energy.	Depends on site design	Depends on site design
Biggest challenge(s)	Community acceptance Cut in wind speed	Small available footprint

Energy performance calculators are available for estimating wind turbine performance, however, for this illustrative analysis, wind speed estimates were selected for appropriate wind speeds using technical sheets for the Endurance 5kW and 50kW wind systems. The estimates have also been de-rated by a 25% turbulence factor (Sagrillo, 2009a).

B.3.3 Wind Energy Technical Potential

As indicated above, in urban areas, it is challenging to find such spaces, and even if such conditions do exist, wind speeds in urban areas are typically too slow as to be appropriate for small-scale wind (Sagrillo, 2009b).

However, as outlined in the methodology section above, two illustrative sites were identified within the 8 council areas that meet the majority of the site selection criteria. Table 24 provides the estimated energy performance of a 5kW and 50 kW horizontal axis wind system at these sites, with an estimated tower height of 40m.

Table 24: Technical potential for small wind systems

	Kogarah: Carss Olympic Pool Wind speed: 4.2m/s @ 40m	**Rockdale: Dolls Point** Wind speed: 4.4 m/s @ 40m
5 kW AEO (kWh/yr)	3,700	3,800
50 kW AEO (kWh/yr)	45,000	56,000

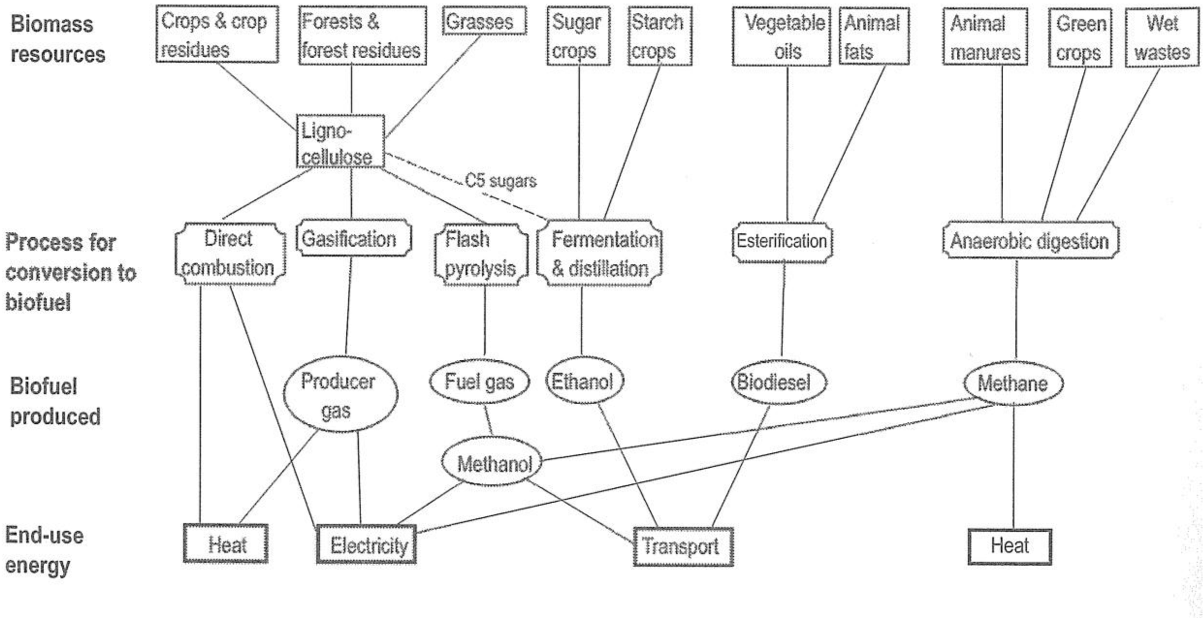
If this technical potential were achieved, the 5kW wind system would offset a portion of one average residential dwelling and the 50kW could offset between six and nine residential dwellings.

B.4 BIOENERGY AND WASTE TO ENERGY

B.4.1 Bioenergy and waste to energy technology overview[35]

One of the features of bioenergy is that there are a huge variety of **feedstocks** (bioenergy fuels or resource types), **processes** for converting feedstocks into useful energy, and **energy use** (for example, heat, electricity, transport). Figure 2 provides an overview of the range of feedstock and processing combinations possible.

Figure 23: Some pathways for converting biomass into useful energy (Diesendorf, 2007)



In an urban environment the types of available bioenergy feedstocks are constrained.

Table 25 outlines the key bioenergy and waste to energy feedstocks available and whether they are predominantly from generated/sourced from council, residential or commercial waste streams (ticks indicate which). While most literature considers waste to energy a form of bioenergy, for the purpose of this report we have made the following distinction between bioenergy feedstocks and waste to energy feedstocks:

- A bioenergy feedstock is a biomass resource, which, while typically a waste product of another process, is naturally produced organic matter e.g. green waste or food waste.
- A waste to energy feedstock is either a man-made organic material such as oils, plastics etc or mixed municipal solid waste which may include some biomass factions, but will predominantly be inert waste, hazardous or man-made organics.

[35] This section has been adapted from the *NSW North Coast Bioenergy Scoping undertaken by the* Institute for Sustainable Futures on behalf of Sustain Northern Rivers (Ison et al, 2013)

Table 25: Bioenergy feedstock classification

Feedstock	Residential	Commercial and Industrial	Council	Most appropriate bioenergy conversion process
Bioenergy				
Food waste	✓	✓		Anaerobic Digestion
Green Waste	✓	✓	✓	Pyrolysis or Direct Combustion
Sewage	✓	✓		Anaerobic Digestion
Waste to Energy				
Mixed MSW	✓	✓		Advanced Gasification, landfill gas capture

For urban areas, there are four main processes (and associated technologies) for converting feedstocks into useful energy:

- **Anaerobic digestion** - this involves the decomposition of organic material in an environment without oxygen - usually a tank (digester) or a covered pond. Bacterial processes break down biomass to form methane. The methane rises to the top of the tank or pond and is drawn off and combusted to produce heat and/or electricity. A liquid fertilizer is one of the by-products of this process.
- **Combustion -** this involves direct burning of biomass material to produce heat and/or electricity. Heat can be produced via a simple boiler, or be used to produce steam to drive a conventional steam turbine to generate electricity.
- **Pyrolysis -** this involves heating biomass in a deoxygenated environment to produce methane and biochar. Biochar is a stable form of carbon that can be used to stabalise the soil and sequester carbon, making it a carbon negative product. The methane is drawn off and combusted to produce heat and/or electricity.
- **Advanced gasification –** this involves turning dry and semi-dry wastes such as MSW into a synthesised gas using a thermal process such as fixed bed gasification, pyro-combustion, fluidized bed gasification, plasma gasification etc.

Information on the different bioenergy technologies can be found in the OEH Bioenergy Resource List (2013). It should be noted that any thermal process will generate emissions including but not limited to particulates and greenhouse gases. As such, the emissions control standards are strict and must be minimised and monitored. The NSW Government currently has a Draft Waste to Energy Strategy to inform the development of thermal bioenergy and other waste to energy processes (EPA, 2013). It should be noted that approaches to waste management is a complex and nuanced area both practically and ethically particularly in relation to waste to energy. While guidelines and emissions standards are essential, the authors of this report question some of the elements of the NSW Draft Waste to Energy Strategy, in particular, its lack of coverage of anaerobic digestion facilities.

B.4.2 Bioenergy methodology

Resource Assessment

A high-level resource assessment and analysis of the feedstocks outlined in has been undertaken for the participating SSROC councils. Based on this resource assessment and analysis, the bioenergy component of the Renewable Energy Master Plan focuses on the anaerobic digestion of food waste. We have also provided a high level analysis of one waste to energy option – the advanced gasification of municipal solid waste (MSW) diverted from landfill.

Feedstock: Food Waste	
Current use/ processing in SSROC	Currently, Leichhardt council is the only participating council that provides separate food waste collection, and then for only 5600 multi-unit dwellings. This goes to the EarthPower food anaerobic digestion facility in Camelia. The remaining residential food waste is part of the mixed MSW waste stream, which either goes to landfill or to a mechanical biological alternative waste treatment plant such as the UR3R at Eastern Creek. Councils generally do not know the end use of commercial and industrial food waste in their area. (Source: *Our Energy Future* member council survey (Q7))
Best fit bioenergy technology	Anaerobic digestion
Opportunity	There is already a food waste anaerobic digestion facility that generates both fertilizer and renewable electricity in Sydney and it is not at full capacity. As such, it is likely that some of the commercial and industrial food waste from participating councils are already going to a bioenergy process. More could be encouraged. Anaerobic digestion is one of the most widely used and uncontroversial bioenergy processes, predominantly as methane is the main gas generated, particulates and other gases are not generated as it is not a high temperature/combustion based energy generation processes (although the methane is combusted).
Challenges	Source separation of residential food waste would be challenging and likely expensive.
Proposed approach for Renewable Energy Master Plan	Anaerobic digestion of both commercial and industrial and residential food waste was considered. However, the costs of setting up a new source separated residential food waste collection system were not factored in as it was considered beyond the scope of this plan.
Estimated recoverable feedstock in participating councils	**Commercial and Industrial food waste – 64,000 tonnes/yr.** Method: DECCW (2010) estimated 303,855 tonnes of commercial and industrial food waste are generated in Sydney annually. This figure was divided by 38 LGAs in the Sydney Metropolitan Area and multiplied by the 8 participating LGAs in this study. **Residential food waste – 30,300 tonnes/yr.** Method: OEH Love Food, Hate Waste estimates that 315kg food waste/household/yr is generated. This was multiplied by the number of households (residential energy customers) in the participating SSROC council areas. It was assumed that only 33% would be recoverable (Hyder, 2012).

Feedstock: Green Waste	
Current use/processing in SSROC	Residential green waste is predominantly sent to composting facilities at Lucas Heights or Eastern Creek, as is some council green waste. For three councils, their green waste is mulched by their own operations. It is unclear where most commercial and industrial green waste is sent. (Source: *Our Energy Future* member council survey (Q7)
Best fit bioenergy technology	Direct combustion or pyrolysis
Opportunity	If councils were to investigate biochar, this could be a carbon negative end use for green waste.
Challenges	Energy generation is considered lower down the waste hierarchy than composting[36], the current end use of most green waste from participating councils. Particularly since composting of green waste can be done aerobically and thus is a greenhouse neutral process. That is, very little methane is released.
Proposed approach for Renewable Energy Master Plan	Bioenergy from green waste has not been considered, given the current end-use is recycling by compost in almost all participating councils.
Estimated recoverable feedstock in participating councils	Not calculated.

Feedstock: Sewage	
Current use/ processing in SSROC	Treatment including anaerobic digestion at Sydney Water's sewage treatment plants.
Best fit bioenergy technology	Anaerobic digestion
Opportunity	New developments could install combined food waste and sewage anaerobic digestions systems at a precinct level and they could be combined with onsite trigeneration.
Challenges	Most sewage is already anaerobically digested at Sydney Water's sewage treatment plants. SSROC would need to work closely with Sydney Water to progress any local sewage anaerobic digestion.
Proposed approach for Renewable Energy Master Plan	Since most of Sydney Water's sewage treatment plants include anaerobic digestion of biosolids, and as such renewable energy is generated. This option is not considered.
Estimated recoverable feedstock in participating councils	Not calculated.

[36] The waste hierarchy is the series of approaches to waste management in order of what is considered best for society, the typical categories in order of preference are 1 avoid, 2 reduce, 3 reuse, 4 recycle (including composting), 5 alternative waste treatment and waste to energy, 6 disposal. However, there is some question about the position of some waste to energy processes on this hierarchy.

Feedstock: MSW	
Current use/ processing in SSROC	Participating SSROC councils do some combination of source separation of recyclables and greenwaste with the remaining waste going to landfill or alternative waste treatment (using a mechanical biological treatment process).
Best fit waste to energy technology	Advanced gasification or pyrolysis
Opportunity	Councils are facing significant waste management challenges, particularly associated with existing landfills reaching capacity in the next few years. This combined with councils' interest in sustainable energy options, means that waste to energy warrants further investigation.
Challenges	Waste to energy through the advanced gasification of the MSW fraction currently diverted to landfill, is a new technological process in Australia. While common overseas, it would require significant learning in the Australia context and as such a range of institutional barriers associated with any new technology should be expected.
Proposed approach for Renewable Energy Master Plan	Technical potential and high level financial analysis undertaken for the establishment of an advanced gasification of MSW facility.
Estimated recoverable feedstock in participating councils	Domestic MSW: 171,000 tonnes/yr. Method: Assumed the 2011/12 waste to landfill amount calculated from the participating council's annual reports and/or State of the Environment reports would remain constant (references in Reference List). As such, this doesn't incentivise the creation of more waste, encouraging source separation and waste management options further up the waste hierarchy.

Scale of bioenergy technology

A preliminary investigation of different scales of bioenergy technology was undertaken prior to the technical potential assessment. At a household and small multi-dwelling scale, ISF found that in Australia and more broadly in developed countries small bioenergy systems are not prevalent. In fact there is little to no precedents, beyond DIY systems. In developing countries, biogas systems for cooking gas are widely used, however there are issues of smell and technology sophistication, that makes technology transfer to the Australian context difficult. To this end, the technical potential of residential or small community scale food waste anaerobic digestion was not calculated. However, there may be interest within the SSROC community to investigate a small anaerobic digestion of food waste pilot project from say one street and/or working in conjunction with a food business like a food cooperative or market.

Investigation of centralised food waste anaerobic digestion was also undertaken. Already, there is an operational food waste anaerobic digestion facility in Sydney – Earthpower. An interview with Earthpower was undertaken, as was a brief literature review of both the resource and energy generation potential of centralised food waste anaerobic digestion. This research identified a rule of thumb to convert tonnes of food waste to kWh of electricity generated. The factor used was 220kWh$_e$/tonne food waste[37].

B.4.3 Bioenergy and waste to energy technical potential

Based on the methodology outlined above, is estimated that commercial and industrial food waste in the participating council areas could generate 14,000MWh/yr at an income of 6.8c/kWh, based on being paid for accepting the feedstock (food waste) rather than having to pay for it. For residential source separated food waste, an estimated 10,000MWh/yr could be generated at an income of 6.8c/kWh not including the cost of source separated food waste collection. Table 26 details additional technical potential information of both bioenergy and waste to energy options.

Table 26: Bioenergy and Waste to Energy Technical Potential

Technology	Capacity potential (kW)	Firm peak capacity potential (kWp)	Energy potential (MWh/yr)	Net Annual GHG abatement potential (KtCO$_2$e/yr)
Anaerobic Digestion - Food Waste (C&I)	4,500	4,275	14,191	12.5
Anaerobic Digestion - Food Waste (Res)	2,120	3,040	6,664	8.9
Advanced Gasification – MSW (Res)	22,000	20,800	153600	Not calculated

[37] David Clark, Earthpower, Personal Communications, 28.07.2013 supported by US food waste anaerobic digestion literature (Moriarty, 2013, p31)

C. FINANCIAL ANALYSIS OF RENEWABLE ENERGY OPTIONS

The key financial analysis factors required by DCODE to calculate the levalised cost of energy of the renewable energy technologies outlined in Section 3.5 are given in Table 27 and the associated costs and sources are also provided.

Table 27: DCODE Factors for Renewable Energy Options

Technology	Life of Capital (yrs)	Net Emissions (tCO2-e/ MWh)	Capital cost of Capacity ($/W)	Fixed O&M costs ($/W/y)	Variable Costs - Fuel and Increm'l O&M (c/kWh)	Capacity Factor (%) [38]	Firm Peak Rating or Firm peak capacity factor (%)
Solar PV (Residential)	25	0.00	2.40	0.08	0.0	16%	0.28
	Common assumption	Scope 1 & 2 emissions of renewable energy generators	Solar Choice price check July (based on 3kW installed price of $1.73/W in Sydney + $0.68/watt solar credits value. Assumes a meter connection costs of $0.1/W. http://www.businessspectator.com.au/article/2013/7/4/solar-energy/solar-pv-price-check-july	Based on Inverter replacement every 10 years @2012 inverter prices $USD710/kW+$100 labour (divided by 10 years). Sunbuzz Global Inverter price index (March 2012) http://www.solarbuzz.com/facts-and-figures/retail-price-environment/inverter-prices	Assumes no ongoing costs besides inverter replacement.	Based on Figure 9.36 where capacity factors in participating SSROC councils are predicted to be (17% - 17.5%). We have discounted to 16% to account for the spectrum of 'optimal' installations. Lilley, B., Szatow, A., Jones, T. (2009). Intelligent Grid: A value proposition for Australia, Energy Transformed Flagship, CSIRO 2009. Figure 9.36	ISF assumption

[38] Capacity Factor = Energy generation (kWh/yr)/Generator size (kW)/# hours in a year) x 100

Solar PV (Non-residential)	25	0.00	2.18	0.08	0.0	16%	0.28
	Common assumption	Scope 1 & 2 emissions of renewable energy generators	Based on ISF market research for 10-100kW system. Installed price of $1.45/W in Sydney + $0.68/watt solar credits value. Assumes a meter connection costs of $0.05/W http://www.businessspectator.com.au/article/2013/7/4/solar-energy/solar-pv-price-check-july	See above.	Assumes no ongoing costs besides inverter replacement.	Based on Figure 9.36 where capacity factors in participating SSROC councils are predicted to be 17.1 -17.5%	ISF Assumption
Solar Hot Water (Residential)	15	0.00	17.52	0.00	0.0	100%	0.1
	Common assumption	Scope 1 & 2 emissions of renewable energy generators	Back calculated from an average installed price of $3500. Assumes 80% electricity boosted, 20% gas boosted. As solar hot water systems typically replace a controlled electric hot water system load, the peak demand reductions are minimal and therefore the cost of capacity appears high; however, the high capacity factor in these calculations means that cost of energy generation/reduction	Assumed zero maintenance costs in lifespan	Assumed zero maintenance costs in lifespan	Assumed 100% for calculation purposes (this is an energy reduction measure). Per system savings are based on SHWS energy savings outlined in iPart, 2011, (Determinants of residential energy and water consumption)	Low peak demand impact as most systems will replace a controlled load water heater.

			is more if measured in $/kWh.				
Bioenergy (anaerobic digestion)	20	0.00	14.00	0.56	-95.5	36%	95%
	Talent with Energy (2013, p107)	Scope 1 & 2 emissions of renewable energy generators	Earthpower personal communications1	ISF Estimate (10% of Capital Cost per year)	Earthpower personal communications3	Earthpower personal communications 4	ISF Estimate
Waste to Energy (advanced gasification)	20	Not calculated	5.20	0.52	-10.6	80%	95%
	Talent with Energy (2013, p107)		Converted from Talent with Energy (2013, p108)	Talent with Energy (2013, p109)	Based on a Landfill Levy of $95/tonne	ISF Estimate	ISF Estimate
Small Wind	20	0.00	10.00	0.25	0.0	12%	0.1
	Industry average	Scope 1 & 2 emissions of renewable energy generators	Industry average	Industry average		ISF Estimate	ISF Estimate

1 $50million for a facility that has 3x1.3MW generators.

2 Talent with Energy (2013, p109) estimates 4% of capital cost, however this seems optimistic given personal communications with Earthpower and as such a conservative figure of 10% is used

3 Councils and commercial operations disposing of food waste pay between $-$/tonne food waste to Earthpower. For the purpose of these calculations the midpoint $210 has been used. The energy conversion factor of 220 kWh/tonne was used to convert to a variable fuel cost factor. Given that the facility is paid for the fuel rather than having to pay for it, the cost is a negative one (aka income).

4 The capacity factor was calculated from the food generator size (3x1.3MW) and the amount of generation potential of the facility at full capacity (50,000 tonnes x 220kWh/tonne) using the following equation:

D. DELIVERY MODELS

The following section presents the possible renewable energy delivery models according to the primary role of the council, which would be one of three roles:

- Owner
- Facilitator
- Delivery models in which council could be a facilitator or a beneficiary

D.1 COUNCIL AS OWNERS

The following service delivery models are ones in which council's primary role is an owner:

A. Council ownership
B. Council partnership with an energy company

A. Council ownership	
Description:	Council purchases renewable energy infrastructure, most commonly to power council buildings.
Key actors:	• Local councils • Organisations using council buildings • Renewable energy technology suppliers
Ownership:	The projects are wholly owned by the councils
Legal structures:	In most cases this would not require any separate legal structure, the council simply purchases the infrastructure.
Financing: Where does the money come from?	Most likely from the council's cash reserves but the council may also seek debt financing from bank of lending institution.
Financial benefit: Where does the money go?	Financial benefit normally flows to the council in the form of cheaper electricity once the upfront cost is paid off.
Role of Council(s):	Choosing, financing, implementation and maintenance of project.
Benefits/pros/ strengths:	• Council has a high level of freedom in choosing how and where projects will be implemented • Many councils have large land and building assets that could potentially provide space for renewable energy systems
Challenges/cons/ weaknesses:	• Council does not have the advantage of the expertise of private sector specialists, although would use some specialists in the design and installation of the renewable energy sytem
Appropriate technologies and scale:	• Smaller scale projects are most suited to solar PV or geo-thermal • Larger projects may include solar, wind or bio-energy

Case study examples	The Local Government Association of South Australia developed a successful program to encourage councils to install solar energy (as well as provide community engagement programs). The Solar Councils program had 34 participating councils and resulted in 4.2MW of solar being installed. Many participating SSROC councils already have small solar pv systems installed, this would be an extension of those existing projects.
Sources / resources	Solar Councils program: http://www.solarcouncils.com.au/home.html http://www.iken.net.au/communities-of-practice/governance-and-leadership/case-studies/case-study-associations-leading-renew

B. Council partnership with energy company	
Description:	A council chooses an energy development company to act as their partner in renewable energy development projects.
Key actors:	• Council • The partner renewable energy developer
Ownership:	The exact ownership model can differ greatly depending on the specifications of the contract. The council, the developer or a combination of both can own the infrastructure. There are benefits in the council retaining ownership, relevant to their investment, of enabling infrastructure such as wires and pipes.
Legal structures:	In the case of ownership of enabling infrastructure by council the legal structure is built around a Use of System Agreement between the developer and the council. No separate legal entity is created. In the United Kingdom an alternative structure is often used where a separate legal entity is formed to own and operate the renewable energy infrastructure. As an example Woking Borough setup Thamesway Ltd (which they fully owned) which in turn invested in a 15-25% share in Thamesway Energy Ltd with the remainder being owned by the partner company. The Borough was able to have a permanent seat o the board of Thamesway Energy Ltd to retain influence over the decision making process.
Financing: Where does the money come from?	The council will usually seed funding from its cash reserves to start the project. Capital investment can be provided by council or sourced from the private sector or partner organisation. In Woking the council first invested in energy efficiency for their buildings and street lights and then used the money saved from this program to fund its investment in Thamesway Energy Ltd.
Financial benefit: Where does the money go?	In the Australian model both the council and the developer receive revenue from the energy installations. Economic benefits can also be delivered to the community in the form of reduced energy costs.
Role of Council(s):	In the early stages of the project the council drives the project by developing a renewable energy plan and contracting a developer to act as the partner. The ongoing role of the council is heavily dependent on the exact specifications of the contract. The council would most likely pass most of the responsibility for day-to-day operations and maintenance to the developer but retain a strong partner role.

Benefits/pros/ strengths:	• The ability to attract a private partner organisation is a good test of the viability of a council's plan. If the council is able to attract a development partner this is a good sign that the project is likely to be financially successful. • A private developer is often able to develop a project faster than the council as they have greater procurement and investment flexibility. They also should have valuable expertise and access to finance. • Once the development is successfully installed on council properties economies of scale make it possible for the partnership to offer renewable energy to other organisations in the council area at a cheaper rate. • A successful partnership can act as a proven example of the business model and thus help the developer obtain credit from the financial community in order to seek similar partnerships with other local governments. It can therefore play a significant role in encouraging the growth in renewable energy use by local governments.
Challenges/cons/ weaknesses:	• The procurement, negotiation and contracting phase of the process can be prohibitively expensive for many local governments. • Once a company is selected as the preferred partner the advantages of a competitive process are immediately lost. This results in a reduction in the power of the councils bargaining position and a greater likelihood of delays, price increases or variations of scope.
Appropriate technologies and scale:	• Potentially available to all renewable energy technologies. • This model works best for medium scale projects. For small scale projects the legal and contractual costs are too high to deliver benefits. For large-scale (city-wide) projects the local government can obtain better value by using competitive tendering processes to deliver projects.
Case study examples	The City of Sydney worked in partnership with Cogent to develop a tri-generation scheme for the new Green Square development. The partnership has recently been cancelled with the City citing changes in the regulatory environment causing the costs of the project to blow out. A 2MW tri-generation plan has been installed in a precinct in Dandenong, this project was delivered as partnership between Cogent and the Victorian Government. Woking in the UK developed a decentralised energy system that reduced the borough's CO2 consumption by 77%; this project was administered through a public/private joint venture company.
Sources / resources	Details of the Woking Case Study: http://www.thamesweyenergy.co.uk/pages/about_us.php?id=12 Cogent details of City of Sydney and Dandenong plans: http://cogentenergy.com.au/case-studies/

D.2 COUNCIL AS FACILITATORS

The following service delivery models are ones in which council's primary role is a facilitator:

C. Bulk buy
D. Community ownership through donations or crowd sourcing
E. Private ownership (large business)
F. Private ownership (residential)
G. Private ownership (developer)

C. C. Bulk Buy/Brokering	
Description:	A bulk buy is where a facilitating organisation gathers many buyers of the same type of product to aggregate buying power and thus receive a lower price. This can be applied for renewable energy systems that are commonly installed such as solar PV and solar hot water systems. The facilitator may select a supplier and/or installer through either a tender process with the final system prices being determined by acceptance of a tender application, negotiation, or via a reverse auction (Dutch auction). Alternatively, the facilitator may select a subset of suppliers/installers offers and allow the buyer to make the final decision on which supplier/installer to go with.
Key actors:	The facilitator The buyers The supplier(s) and/or installer(s)
Ownership:	Each system would generally be owned by the buyers
Legal structures:	n/a
Financing: Where does the money come from?	The buyer must finance the system upfront, but may seek third party financing to do so. The facilitator may seek to coordinate low-interest financing from a lending institution as an option for the individual buyers (the facilitator may also consider a small 'finders fee' from each buyer).
Financial benefit: Where does the money go?	By supplying in bulk, a solar supplier and/or installer should receive certain cost savings through: avoided marketing cost, bulk goods order and delivery, bulk processing of subsidies, lowered travel time between installations, and so on. A proportion of these cost savings should be passed on to the buyers in the form of a lowered system cost.
Role of Council(s):	The council or a group of councils may wish to either facilitate a bulk buy program for local residents and businesses, or participate as a buyer in a bulk-buy program in conjunction with other councils.
Benefits/pros/ strengths:	A bulk buy program can: • Lower installed cost of renewable energy for participants • Potentially lower the buyer's transaction costs associated with researching an appropriate PV supplier and installer and uncertainty around PV supplier/installer credibility (as the supplier and installer would be screened by the facilitator). • Overcome information barriers to renewable energy uptake through community education and support decision-making through access to credible, accurate information
Challenges/cons/ weaknesses:	Weaknesses/cons from the perspective of the PV host: • The costs of administering a bulk buy may be substantial for the facilitation organisation. These costs include skilled staffing, promotion in media and community circles, information sessions, factsheets, offer documents. • The bulk buy may limit the flexibility in system types and sizes • In today's highly competitive solar PV market, supplier and installer margins may permit less discount potential from the average installed price, relative to bulk-buy programs conducted just a few years ago.
Appropriate technologies and scale:	**Residential Sector:** Solar PV and solar hot water systems present obvious renewable energy bulk buy program opportunities **Commercial sector:** Solar PV bulk buy program could be effective. Solar hot water

	requirements are likely to be too site specific to allow an effective commercial solar hot water bulk buy.
Case study examples	Parkes Shire Council Solar Communities Program: The Parkes Shire invited residents living within 100km of Parkes to express interest in purchasing solar panels. They are then able to negotiate with councils to bulk buy panels at a discounted rate. Three other Australian case studies are discussed on the Embark website in detail: • Moreland Energy Foundation solar PV bulk buy • Bendigo region Solar Rooftops Project • BREAZE's second solar PV bulk buy • www.embark.com.au/display/public/content/bulk+buy+programs
Sources / resources	Establishing a bulk-buy program, by Sarah Morton. Available at Embark website: www.embark.com.au/ The Solarize Guidebook: A community guide to collective purchasing of residential PV systems (US). Available via NREL: www.nrel.gov/docs/fy12osti/54738

D. Donation based fundraising

Description:	Renewable energy infrastructure that is funded through donations. This may be facilitated using traditional charitable fundraising methods such as events, raffles etc or through a crowd funding platform (online fund-raising for a specific objective) to generate initial funding. The reliance on donations to raise capital means that this model is most likely to be used for adding renewable energy to community assets (school, sports club, community hall, church etc) to lower power bills rather than building large renewable energy systems.
Key actors:	• The organisation responsible for the community assets • Community members with a stake in the asset • Councils • Potentially parent organisations (e.g. Church organisation beyond the local community; Department of Education etc
Ownership:	The organisation that owns the community asset and undertakes the fund-raising owns the renewable energy infrastructure; that is the school, the church or sports club owns the renewable energy system.
Legal structures:	The community asset which owns the renewable energy system could be a non-profit, for-profit, or government owned organisation.
Financing: Where does the money come from?	Financed through donations, may also receive support through grant programs etc.
Financial benefit: Where does the money go?	To the community asset by way of lower electricity bills
Role of Council(s):	Promote; facilitate and/or provide advice
Benefits/pros/ strengths:	• Reduces electricity bills for the community asset • Engages and educates community members who make use of the asset

	• Can utilise successful existing crowd-funding websites such as Kickstarter; Pozible; Start Some Good
Challenges/cons/ weaknesses:	Charitable fundraising can be challenging; this is especially the case for community assets that are seen to be commercial in nature or only used by a small proportion of the community.
Appropriate technologies and scale:	There is no actual physical limit beyond what planning laws allow for in the relevant location. The ability to raise funds may provide a practical limit. As a guide typical technologies may include: • Solar PV of less than 20kW • Small wind turbines of less than 10kW • Solar hot water if the asset has heating needs
Case study examples	There are a number of examples of this model in Scotland supported by Community Energy Scotland (for examples see http://www.communityenergyscotland.org.uk/projects/list/p2), specifically Community Trusts fundraise through donations, grants and debt financing to install a renewable energy system on village halls or larger systems that are owned and generate money for the Community Trust. There are no known cases in Australia that use online crowd funding. It is likely that there are examples of renewable energy infrastructure being funded by traditional donating but the small and local nature of these projects make them difficult to identify.
Sources / resources	Kickstarter: www.kickstarter.com Pozible: www.pozible.com Start Some Good: http://startsomegood.com ChipIn: www.chipin.org.au

E. Private Ownership (business)

Description:	This is a standard business model where a private company that is a large energy user in the region purchases and owns a renewable energy system, generally to use the electricity onsite.
Key actors:	• The private company • Shareholders • Banks or other financing institutions
Ownership:	The large business owns the infrastructure.
Legal structures:	No new company, or the business may choose to set up a subsidiary company to own the renewable energy asset
Financing: Where does the money come from?	The financing for the project comes from a combination of the companies own cash reserves, equity investment, and/or debt financing from a banking or lending institution
Financial benefit: Where does the money go?	All profits from the renewable energy infrastructure accrue to the company and its shareholders, typically by way of lower electricity bills.

Role of Council(s):	Local government may be required to provide planning approval.
Benefits/pros/ strengths:	• Established companies should be able to obtain sufficient funding to invest in relatively large-scale renewable energy plants. • Can substantially reduce energy bills and provide greater certainty around future energy liability • Provides a marketing opportunity for the company as a social and environmentally responsible organisation.
Challenges/cons/ weaknesses:	• There is minimal opportunity for community involvement in the planning and operations of the plant. • The local community and council may receive little of the economic benefits created by the project.
Appropriate technologies and scale:	While all technology options workable in the SSROC region are appropriate at medium to large scale, solar PV, solar hot water and ground source heat pumps are likely to be the most appropriate for large businesses in the SSROC region.
Case study examples	Sydney Theatre Company and Ikea are two businesses that have or are planning to install large solar PV systems.
Sources / resources	

F. Private Ownership (Residential)	
Description:	Private households install renewable energy directly on their property. The household can use the power they produce and/or export the power to the grid and receive a feed-in tariff (if one is available). Some banks, financial institutions, and local councils provide schemes to encourage the uptake of renewable energy.
Key actors:	• Individual households • Renewable energy installers and suppliers • Banks or other credit agencies
Ownership:	The individual household owns the infrastructure.
Legal structures:	Ownership by the household.
Financing: Where does the money come from?	Financed by the individual household either through savings, debt financed through a bank or lending institution. In many cases, the solar developer will have partnered with a lender to provide quick access to financing. There are various banks who offer loans with discounted interest rates for the purchase of renewable energy systems. For example: http://www.bendigobank.com.au/public/generationgreen/green_loans/generation_green_home_loan.asp?zoom_highlight=green+loans http://www.communityfirst.com.au/Green-loans Some municipalities in the United States allow households to defer the cost of their renewable energy installation by paying back the loan as part of their property taxes. http://en.wikipedia.org/wiki/PACE_financing Some companies offer households a pay-as-you-go model with no upfront costs and the infrastructure paid through savings in household electricity bills. An innovative example of this model is Sungevity which also provides a donation to environment organisations such as GetUp! http://www.sungevity.com.au/pay-as-you-go-solar

Financial benefit: Where does the money go?	Households make a saving from needing to import less electricity from the grid. If they generate more electricity than they use they are also eligible for a feed-in tariff. In NSW the current IPART benchmark for feed in tariffs is 7.7 – 12.9c/kWh. Residents also receive Small-scale Technology Certificates under the federal Renewable Energy Target policy which can be sold.
Role of Council(s):	Councils can play a number of important roles in encouraging households in their area to take up renewable energy. They can act as an: Aggregator: They can coordinate a bulk buy of solar panels by aggregating the demand for the panels within their jurisdiction (see bulk buy delivery option). See the Parkes case study below. Champion: They can champion solar panels by advocating for local banks to offer discounted loans and promoting renewable energy to households in their area. Vetter: They can assess local suppliers and installers of renewable energy and provide a list of recommended businesses.
Benefits/pros/ strengths:	• Individual households have control over their own purchase and use of renewable energy • Leads to a growth in the number of members in the community who are knowledgeable and supportive of renewable energy
Challenges/cons/ weaknesses:	• Is difficult to implement for tenants and people with lower incomes, although the Sungevity pay as you go model may make this easier. • Very limited economy of scale (unless purchases are aggregated).
Appropriate technologies and scale:	Whilst other technologies are sometimes used the vast majority of residential renewable energy is solar PV of 3kW or less.
Case study examples	
Sources / resources	Information on feed-in tariffs: http://www.ipart.nsw.gov.au/Home/Industries/Electricity/Reviews/Retail_Pricing/Solar_feed-in_tariffs_2013_to_2014 Information on Small-scale Technology Credits: http://ret.cleanenergyregulator.gov.au/About-the-Schemes/Small-scale-Renewable-Energy-Scheme--SRES-/about-sres

G. Private Ownership (developer)

Description:	The standard business model where a renewable energy developer either develops and owns a renewable energy project or develops and sells a renewable energy project.
Key actors:	• Renewable energy developer • Banks/financing institutions • Landowners • Council (planning approval)
Ownership:	The developer owns and manages the renewable energy asset or sells it on to another party, such as an energy gentailer (Origin, AGL etc) or another developer.
Legal structures:	No new company, or the developer may choose to set up a subsidiary company to own the renewable energy asset
Financing: Where does the money	The financing for the project comes from a combination of the companies own cash reserves, equity investment, and/or debt financing from a bank or lending institution.

come from?	
Financial benefit: Where does the money go?	All profits from the renewable energy infrastructure accrue to the developer and its shareholders.
Role of Council(s):	Local government may be required to provide planning approval.
Benefits/pros/ strengths:	• Established companies should be able to obtain sufficient funding to invest in relatively large-scale renewable energy plants. • Established renewable energy providers will have experience and expertise in the development of plants.
Challenges/cons/ weaknesses:	• There is minimal opportunity for community involvement in the planning and operations of the plant. • The local community and council may receive little of the economic benefits created by the project.
Appropriate technologies and scale:	All technologies are appropriate at medium to large scale.
Case study examples	There are many illustrations of this model in practice, examples include: Earthpower Anaeorbic Digestion Plant: This plant in Camellia in Western Sydney converts source separated food waste into biogas and nutrient rich fertiliser. The $35m plant processes 600 – 800t of food waste per week in an anaerobic digester and powers three 1.3MW generators. The sludge by-product is dried using heat created by the digester to create fertilizer. For more information see: http://www.earthpower.com.au/creating_green_energy.aspx There are several large commercially owned wind farms in rural and regional NSW such as the Capital Wind Farm (141 MW); Gunning Wind Farm (46.5 MW); and the Cullerin Range Wind Farm (30 MW) all in the Goulburn region.
Sources / resources	

D.3 COUNCIL AS MULTIPLE ROLES

The following service delivery models are ones in which council's primary role could be a facilitator or a beneficiary:

- **H. Community**
- **I. Leasing**
- **J.** Urban / rural partnerships
- **K.** Developer and community partnerships
- **L.** Crowd-funding
- **M.** Energy performance contracting

H. Community Ownership	
Description:	A renewable energy infrastructure project developed and owned by community members
Key actors:	The project is driven by a local community group who may receive assistance (advice, technical assistance, capacity building etc.) from community renewables support organisations. The community group could include:

	• Individual community members ('mum and dad' investors) • Small businesses • Councils • Local NGOs/charities/sustainability groups
Ownership:	Owned by members of the community who invest in the project
Legal structures:	A new organisation is set up, to own the renewable energy asset. The members of the organisation are the investors in the asset. Typical legal structures used are: • Cooperative; • Private Company; • 'B' (or benefit) Corporation. This is a new corporate model being developed in the United States that aims to provide a legal structure for companies who wish to create benefit for all stakeholders rather than just shareholders.
Financing: Where does the money come from?	In the early stages grants and donations can be used to get planning approval and get the project investment ready. Once this is achieved local members can invests (as equity members). If the upfront capital requirements are large, debt financing from a bank or lending institution can supplement initial equity investment.
Financial benefit: Where does the money go?	Revenue can be used to: • Pay-off debt • Returned to members as a dividend • Seed a new project • Setup a community grant fund
Role of Council(s):	The council can: • Provide early stage grants or seed funding • Provide a site • Become a member investor • Be a project champion
Benefits/pros/ strengths:	• Full ownership by the community allows complete democratic control over the infrastructure • Localised energy supply and money from renewable energy investment stays in the community • Provides an ethical investment opportunity for mum and dad investors • Social benefits such as increased energy literacy, individual capacity building, strengthened community networks and more
Challenges/cons/ weaknesses:	• Capital raising both at the developmental and implementation stage has posed the greatest challenge to community organisations • Getting a fair price for the electricity generated • Connecting to the grid
Appropriate technologies and scale:	• Solar PV 50-100skW; • Wind 1-10MW; • Bio-energy 500kW – 10MW
Case study examples	See community renewable energy projects in development in Australia and Europe at http://tiny.cc/3udxzw Operating community renewables projects in Australia include: Hepburn Wind: A 4.1MW community owned wind plant in central Victoria http://hepburnwind.com.au/ Denmark Community Windfarm: A community owned wind farm that began generating electricity in February 2013 http://www.dcw.org.au/community.html

Sources / resources	Community Power Agency: http://www.cpagency.org.au/index.php NSW Renewable Energy Precinct program: http://www.environment.nsw.gov.au/climatechange/reprecinctresources.htm Embark: http://www.embark.com.au/display/WebsiteContent/Home

I. Leasing/Power Purchase Agreement (PPA)	
Description:	A lessor owns and installs a renewable energy system on the roof of an electricity user. The electricity user, or host, agrees pay for the use of the system through a regular payment in return for being able to use the electricity and thus benefit through electricity bill reduction. This delivery model only currently works for solar PV. This payment to the lessor may be in the form of a regular predetermined amount (regular lease payment) or tied to how much PV electricity the host actually consumes ('behind-the-meter'), whereby the payments are made through private billing based on a predetermined electricity price (known as a Power Purchase Agreement).
Key actors:	The developer The electricity user who hosts the PV system The financier who provides the upfront capital investment
Ownership:	The renewable energy developer owns the PV system
Legal structures:	The developer is typically a company
Financing: Where does the money come from?	The developer facilitates a contractual arrangement between the developer, the PV host, and a third-party financier such as a banking or investment institution, who pays for the upfront capital costs in return for ongoing repayments (which will be communicated to the host in the form of a lease or PPA). The PV host will be required to pass regular credit checks in order to enter into any contractual agreement.
Financial benefit: Where does the money go?	The economic benefits of the PV system are split between three main parties: 1. The PV host receives financial benefits in the form of a electricity bill reduction, which should be greater than the ongoing payments to the developer 2. The developer receives financial benefit from facilitating the process 3. The financiers receive financial benefits as they receive a return on their upfront capital investment
Role of Council(s):	Facilitation: The council could act as an independent information provider The council could receive commissions from acting as a brokering agency (e.g. the Sungevity affiliates model) The council may wish to host a PV system owned by a PV host
Benefits/pros/ strengths:	Benefits to the PV host: • financially ahead from day one (with appropriate system sizing) • maintenance of PV system – including replacement/repairs are typically (but not always) covered by the developer . • buy-out clauses may allow the user to purchase the system at a predetermined price after a certain time period. • contract can be transferred to next building occupant if moving (provided the next occupant agrees). • The host incurs low transaction costs when installing the system (the developer does all the work)
Challenges/cons/ weaknesses:	Weaknesses/cons from the perspective of the PV host: • The developer owns the PV system

	• Financial benefits are shared with developer and investors and are therefore lower than with outright ownership • Long contract period of 7-20 years • Potentially high costs are incurred if ending lease period early (e.g., if moving). • Contract may be complex for many PV hosts to understand • changes to the electricity user's electricity use profile may reduce the benefits received from bill reduction, perhaps to an amount lower than the lease value. • The developer may ask the electricity user to insure the PV system as part of home and contents insurance, which increases insurance premiums
Appropriate technologies and scale:	Solar – residential (1-5kW) and commercial scale (5kW-100kW)
Case study examples	
Sources / resources	Information summaries: • Solar Choice's factsheet on solar leasing in Australia • Solar Leasing for residential systems, National Renewable Energy Laboratory (NREL). http://www.nrel.gov/docs/fy09osti/43572.pdf (United States) The number of companies in Australia offering a solar lease or PPA is growing quickly. Here are the website links to a few organisations operating in Australia who offer a lease or PPA service: • www.everyrooftop.org.au initiative, Green Cross Australia (useful solar leasing information on their solar leasing program) • www.Ingenero.com.au (Offers residential and commercial solar leasing, and commercial PPA) • www.sungevity.com.au (Offers a residential and commercial PPA) • www.energymatters.com.au (Offers commercial solar PPA) •

J. Urban/Regional partnerships

Description:	Rural/urban partnership is the idea that councils or communities in an urban area like southern Sydney could partner with councils or communities in a rural or regional area that has a good renewable energy resource. There are many possible variations of how a rural/urban partnership might work and it is likely that this model could contain elements of the other models presented here.
Key actors:	• Rural councils • Urban councils • Community groups (urban and rural) • Renewable energy developers
Ownership:	There is a range of possible ownership models. Ownership would likely include some of the following actors: • Relevant rural and urban councils • Individual community members in each area • Businesses in each area • Landholders

	• Renewable energy developers The Alternative Technology Association is currently setting up a process where individuals or organisations could purchase renewable energy certificates directly from specific renewable energy projects and thus could help facilitate linkages between urban and rural groups.
Legal structures:	Many possible variations including: • Cooperative • Private company (new or existing) • Renewable energy developer as main owner
Financing: **Where does the money come from?**	This would depend on the ownership and legal structure chosen for the project.
Financial benefit: **Where does the money go?**	• The legal owners of the renewable energy infrastructure • The rural community through a community fund • Urban consumers (through a dividend if they are part owners in the renewable energy asset)
Role of Council(s):	This model would most likely require the urban and rural councils to form a strong and active partnership. The councils could take a lead role in the coordination and facilitation of the project. The councils may also be owners and consumers of the electricity produced (indirectly via purchase of renewable energy certificates).
Benefits/pros/ strengths:	The limitations of space and strict planning regulations mean that many renewable energy options cannot be installed in urban areas. A partnership with a rural area expands the options and scale available to an urban area and makes better use of renewable energy resources in rural areas. Additionally, as larger renewable energy projects are possible, greater economies of scale are possible, increasing the economic viability of such projects. The partnership would also provide direct benefits to the rural economy as well as increasing the connections between the rural and urban areas potentially providing spin-off benefits such as increased tourism or business exchanges.
Challenges/cons/ weaknesses:	The need to distribute the electricity over a long distance using the national electricity market infrastructure means that the project would not achieve the localised economic and technical benefits that other embedded energy generation projects could in the future achieve. Most of the other business models presented here rely on renewable energy infrastructure that is located within or nearby the local community who are consuming the energy. This proximity of the infrastructure helps provide opportunities for engagement, education around energy issues and community building. In the rural/urban partnership the energy generation infrastructure and the end consumer are physically distant and this may be mirrored by a psychological distance that makes it difficult to achieve some of the social benefits that other models are able to provide. The location of the renewable energy generation may also make it more difficult

	to claim projects as contributions to achieving renewable energy objectives such as the SSROC renewable energy target.
Appropriate technologies and scale:	This model presents the opportunity for larger scale plants than are available to models involving generation in urban areas. All of the technologies below would probably be suitable in this model at scales of 1MW to 100MW. • Wind • Bio-energy • Concentrating solar thermal
Case study examples	There are no known examples of the rural/urban renewable energy partnership, although Clean Energy for Eternity in Mosman and Bega did investigate an urban/rural community solar project. Similar ideas have been used in the food industry with urban community groups and food cooperatives forming partnerships with organic farmers to provide food. Groups such as Food Connect (http://www.foodconnect.com.au/) have developed this idea into a successful commercial business model.

K. Developer and community partnerships	
Description:	A renewable energy developer partners with a community group to develop, own and finance a renewable energy asset/project.
Key actors:	• Renewable energy developer • Community group
Ownership:	There are various possibilities. The renewable energy project could be owned by an organisation, which in turn is part owned by the renewable energy developer and part owned by a community group/company/cooperative. Alternatively, the renewable energy developer could give a community group/company/cooperative the option to buy part of the project i.e. one or two wind turbines while hiring the developer to operate and maintain the infrastructure.
Legal structures:	Various possibilities dependent on ownership (as above). Companies or cooperatives are most typical.
Financing: Where does the money come from?	Typically: • Developer funds technical feasibility • Community funds community engagement • Both have a role in capital raising
Financial benefit: Where does the money go?	• Profits to the developer • Dividends to community investors • Possibly a community grant fund
Role of Council(s):	• Facilitation and coordination • Possible partner or member of a community cooperative/company
Benefits/pros/ strengths:	• Plays to the strengths of the each organisation • Greater economies of scale as the developer is likely to be able to access capital beyond what is possible for the community alone
Challenges/cons/	• Getting the right mix of organisations is vital

weaknesses:	• Slightly lower returns for developer than if developed purely commercially • Less community input into decision making than if fully community owned
Appropriate technologies and scale:	All technologies at scales of greater than 50kW
Case study examples	Infigen Energy helped establish and is now working with the Central NSW Renewable Energy Co-operative on the Flyers Creek Wind Farm. Infigen will own the majority of the wind farm, while the Central NSW Renewable Energy Co-operative will own one or two of the wind turbines. In Germany and Denmark many wind farms operate on this model, indeed, in Denmark, it is legally mandated that onshore wind farms must offer communities in the area the opportunity to purchase up to a 20% stake in the wind farm. In the UK Energy4All which is a cooperative of 7 wind energy cooperatives works with Falke Renewables to develop community and developer partnered wind farms.
Sources / resources	Central NSW Renewable Energy Cooperative: http://27.111.87.44/~cenrecco/?page_id=2 Energy4All http://www.energy4all.co.uk/ Community Power Agency http://www.cpagency.org.au/index.php

L. Crowd funding (investment)

Description:	This model relies on crowd funding to attract equity investment in a renewable energy project/asset. Crowd funding is typically a donation based funding model, however increasingly internationally dedicated crowd funding platforms are being used to attract investment in social enterprises such as renewable energy projects. However, in Australia funding the legal status of investment based crowd funding is still unclear.
Key actors:	• A renewable energy project developer with specialist expertise in crowd funding investment • A crowd funding investment platform • Individual investors who interact with the project online
Ownership:	The funders receive an equity investment in the project (or controlling company) that owns the renewable energy infrastructure.
Legal structures:	While the ‘pledge and reward’ (where a funder receives a gift for their donation) model of crowd funding used by sites such as Kickstarter and Pozible has been relatively unrestricted by regulation it does not allow the possibility of legally binding investment. The potential of using crowd funding for the sale of equity investment is still very new and globally the regulations relating to it are still being developed. New regulations in the Netherlands and the UK are already allowing small-scale equity investment. In the US the JOBS Act (2012) was designed to open the market for crowd funded investment, so far this is restricted to ‘accredited investors’ but this is expected to change when the Securities and Exchange Commission releases new rules relating to crowd funding. Crowd funded investment “as a discrete activity is not prohibited in Australia” (ASIC 2012 – see below) but the legal barriers make it very difficult to implement, especially for small groups. The provision of equity imposes a number of legal obligations on the crowd funder including the need to form a public company and

	provide a prospectus. The ASIC media release clarifying the legal position of crowd funding can be found at this link: http://www.asic.gov.au/asic/asic.nsf/byheadline/12-196MR+ASIC+guidance+on+crowd+funding).
Financing: **Where does the money come from?**	Any interested investor who is free to make an investment of any size. The money is only taken once the crowd funded project achieves a set level of funding that makes it achievable to implement.
Financial benefit: **Where does the money go?**	• Dividend or other financial benefit for investors • A project development fee or dividend to the renewable energy developer
Role of Council(s):	The council could play a key role as a 'champion' and facilitator of the project.
Benefits/pros/ strengths:	• The equity provided to funders could provide a greater incentive to provide funds than if a donation model is used • Could include a range of investors from individuals providing very small investments to larger companies and institutional investors • The rapid growth of crowd funding means there is potentially a large market of investors • If done right it is very easy for people to invest
Challenges/cons/ weaknesses:	• The lack of clarity around legal obligations and while strictly legal, there is no Australia precedent and the legal obligations are likely too high to make the streamlined processes used internationally in this model a viable one at this point • No Australian investment crowd funding platform currently exists • The need to form a public company presents a hurdle that would make this model more appropriate for larger scale projects
Appropriate technologies and scale:	In the UK and US projects have concentrated on solar PV and wind projects of sizes from 1.5kW to 500kW.
Case study examples	There are no examples of this model in Australia. However in the UK Abundance Generation has funded two solar projects and one wind project worth a total of £2.65m. In the US Mosaic Inc. has funded fourteen renewable energy projects totalling an investment of $2.1m.
Sources / resources	Mosaic Inc. are a US based company clean energy finance company. They currently are only able to offer investments to accredited investors based in the US. https://joinmosaic.com/ Sunfunder is an investment company that specialises in solar projects in the developing world. Currently it is only able to offer investors with repayment of their investment but not interest. http://www.sunfunder.com/ Abundance generation Is a UK based clean energy finance company that is open to investments from the UK.

	https://www.abundancegeneration.com/ Information about the state and regulatory position of crowd funding can be found in the two articles below: http://www.afr.com/p/markets/capital/crowdfunding_the_threat_for_bankers_v2USe2vmr9geskvkyIFYsL http://www.minterellison.com/publications/asic-media-release-on-regulation-of-crowd-funding-in-australia/

M. Energy performance contract for renewable energy

Description:	Energy performance contracts are a relatively new method of financing upgrades to energy systems. A energy performance contract is signed between the customer (a public or private organisation) and the energy service company (ESCO), this contract stipulates a guaranteed level of energy savings that the organisation will receive and a management fee that will be paid to the ESCO. The ESCO is responsible for the implementation and maintenance of the energy savings program and the management fee is not paid if the guaranteed savings are not achieved. In this way the technical and, in some cases, financial risks of energy savings programs are transferred from the customer to the ESCO. Energy performance contracts (EPCs) are most commonly used for energy efficiency upgrades but can also be used for the implementation of renewable energy infrastructure.
Key actors:	• Customer organisation • Energy service company
Ownership:	There is no requirement to setup any new entity to manage the process. The ownership of the renewable energy infrastructure installed on the customer's site would need to be determined through the contracting process.
Legal structures:	The EPC is the legal document that binds the ESCO to provide the customer organisation with the energy savings that have been agreed to. The Australasian Energy Performance Contracting Association and the Australian Greenhouse Office have developed a standard contract that may be used. Individual organisations may wish to amend this to suit their own circumstances. Detailed information on using the standard contract can be accessed in the 'Best practice guide to Energy Performance Contracts' available at: http://www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_energy_performance_contracts.pdf
Financing: **Where does the money come from?**	In most cases the customer provides the initial funding for the infrastructure, which is then paid back through the guaranteed savings. If the customer is required to access credit than the EPC can be setup so that the guaranteed savings exceed the loan repayments. Although less common some EPCs are funded by third party organisations organised by the ESCO or by the ESCO itself.
Financial benefit: **Where does the money go?**	The contract is set up to be mutually beneficial for the customer and the ESCO. The customer generates electricity savings in excess of the cost of the management fee paid to the ESCO. The management fee paid to the ESCO is greater than the cost of operating and maintaining the equipment. The ESCO should generate a profit unless it is unable

	to provide the customer with the guaranteed level of electricity savings.
Role of Council(s):	Councils are most likely to play the role of a customer organisation, however they may wish to also champion the use of EPCs and facilitate organisations and ESCOs meeting.
Benefits/pros/ strengths:	For the customer the advantages include: • Removal of technical risk; the ESCO assumes the risk associated with the project not performing as designed, experiencing technical difficulties or requiring ongoing maintenance. • Guaranteed energy savings • Having an on-going relationship with a firm with technical expertise. This reduces the costs of tendering or equipment purchase, allows for ongoing improvement in performance, and allows the customer organisation to focus on its main objectives.
Challenges/cons/ weaknesses:	• The flip side of a long-term contract is that it reduces flexibility by limiting the organisations ability to contract other providers. • The need to pay management fees to the ESCO makes this model more suitable for larger projects than smaller projects. • The longer payback periods for renewable energy programs in comparison to energy efficiency mean that EPCs need to be longer term contracts.
Appropriate technologies and scale:	Any technology used would need to be appropriate for installation on the organisation's facilities, with solar PV probably providing the greatest flexibility of installation. The finances of this model suggest that it would be of most value to medium to large organisations with energy bills in excess of $500,000 p.a.
Case study examples	There are many examples of the use of EPC, for example in the United States the federal government has signed EPCs worth $5 billion. Institutions in Australia such as the Australian Museum and the New South Wales State Library have also signed EPCs. However in these cases renewable energy plays only a small role (if any) with the main focus being on energy efficiency measures. There are few examples of EPCs being used to fund projects that are based solely around renewable energy.
Sources / resources	The Australasian Energy Performance Contracting Association and the Australian Greenhouse Office have developed the 'Best practice guide to Energy Performance Contracts' available at: http://www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_energy_performance_contracts.pdf

N. Environmental Upgrade Agreements

Description:	Council enters into an agreement with a commercial building owner and finance institution. The agreement has three components: 4. Financial institution advances funds to building owner for environmental retrofitting works 5. Council levies an "environmental upgrade charge" on the building through rates collection. 6. Council uses the charge to repay the loan from the financial institution. The charge will remain on the rateable land until the funds advanced by the financier are repaid in full. Where agreement is made with tenant's consent, the property owners can pass part of the environmental upgrade charge to the building occupiers (tenants).
Key actors:	• Council • Building owner (and tenants) • Financial Institution

Ownership:	Ownership is initially shared by all parties until the initial loan is paid off. Thereafter, any infrastructure would belong to the building owner.
Legal structures:	An 'Environmental Upgrade Agreement' is the legal document that binds the building owner and council.
Financing: **Where does the money come from?**	Funds are provided by private financial institutions.
Financial benefit: **Where does the money go?**	The funds are provided to the building owner to cover the cost of the upgrade. Funds are repaid with interest to the financial institution, although no interest loans could be established.
Role of Council(s):	• Enter into an agreement with the building owner • Levy the Environmental Upgrade Charge through rates • Pass on the charge to the lending body
Benefits/pros/ strengths:	• Assists building owners to obtain finance
Challenges/cons/ weaknesses:	• Is only applicable to very large energy users • Is administratively complex
Appropriate technologies and scale:	Commercial building retrofitting
Case study examples	City of Melbourne Environmental Upgrade Charge, as enabled by an amendment by Victorian Parliament to the *City of Melbourne Act 2001*
Sources / resources	www.melbourne.vic.gov.au/1200buildings/pages/funding.aspx

E. PRIORITISING OPTIONS PROCESS

Through the three stakeholder workshops, two processes were undertaken to prioritise the renewable energy and delivery model combination options - were a tally process and a multi-criteria analysis. For the enabling action recommendations, stakeholders were asked to discuss barriers, questions and ideas they had that could address/undertake to help them implement renewable energy. The tally and multi-criteria processes are described in detail in the following sections.

E.1 TALLY PROCESS

The tally process involved, inviting workshop participants to star the top five technology and delivery model combinations that they wanted for inclusion in the next phase of the *Our Energy Future* project, from a full list of 36 options. The results of this process from the three workshops are given in Table 28, Table 29 and Table 30.

Table 28: Community Tally Process Results

Delivery Model	Technologies	Score (# of stars)
COMMUNITY MEMBERS AS OWNERS		
1. Bulk buy	Solar PV	11
2. Bulk buy	Solar Hot Water	7
3. Community ownership	Solar PV	16
4. Community ownership	Bioenergy (Anaerobic Digestion)	4
5. Private (residential)	Solar PV	4
6. Private (residential)	Solar Hot Water	2
7. Developer & Community partnership	Solar PV	2
8. Developer & Community partnership	Bioenergy (Anaerobic Digestion)	2
9. **Council partnership with Energy company**	Waste to Energy (Advanced Gasification)	5
10. Crowd-funding	Solar PV	4
COMMUNITY MEMBERS AS PARTICIPANTS		
11. Community (donation)	Solar PV	2
12. Community (donation)	Solar Hot Water	
13. Community (donation)	Small Wind	
14. Leasing	Solar PV	9
15. Rural/Urban	Large Wind	8
16. Rural/Urban	Solar PV	5
17. Rural/Urban	Bioenergy	3
18. Rural/Urban	Concentrating Solar Thermal	8
COMMUNITY MEMBERS AS ADVOCATES		

19. Council ownership	Solar Hot Water	3
20. Council ownership	Solar PV	7
21. Council ownership	Bioenergy (Anaerobic Digestion)	7
22. **Council ownership**	Waste to Energy (Advanced Gasification)	6
23. Council ownership	Small Wind	1
24. Council partnership with Energy company	Bioenergy	8
25. **Council partnership with Energy company**	Waste to Energy (Advanced Gasification)	6
26. Private (business)	Solar PV	
27. Private (business)	Solar Hot Water	1
28. Private (business)	Small Wind	
29. Private (developer)	Bioenergy (Anaerobic Digestion)	1
30. **Private (developer)**	Waste to Energy (Advanced Gasification)	
31. Private (developer)	Solar PV	1
32. Energy performance contract	Solar PV	2
33. Energy performance contract	Solar Hot Water	

Table 29: Council Tally Process Results

Delivery Model	**Technologies**	**Score (# of stars)**
COUNCIL AS OWNERS		
1. Council ownership	Solar Hot Water	2
2. Council ownership	Solar PV	8
3. Council ownership	Bioenergy	3
4. Council ownership	Small Wind	1
5. Council ownership	Waste to Energy	n/a
6. Council partnership with Energy company	Bioenergy	11
7. Council partnership with Energy company	Waste to Energy	8 - 5
COUNCIL AS FACILITATORS		
8. Bulk buy	Solar PV	17
9. Bulk buy	Solar Hot Water	5
10. Community (donation)	Solar PV	0
11. Community (donation)	Solar Hot Water	0

12. Community (donation)	Small Wind	0
13. Private (residential)	Solar PV	3
14. Private (residential)	Solar Hot Water	2
15. Private (business)	Solar PV	7
16. Private (business)	Solar Hot Water	0
17. Private (business)	Small Wind	0
18. Private (developer)	Solar PV	2
19. Private (developer)	Bioenergy	4
20. Private (developer)	Waste to Energy	n/a
COUNCIL AS FACILITATOR OR PARTICIPANT		
21. Community investment	Solar PV	9
22. Community investment	Bioenergy	2
23. Leasing	Solar PV	10
24. Rural/Urban	Large Wind	6
25. Rural/Urban	Large Solar PV	5
26. Rural/Urban	Bioenergy	1
27. Rural/Urban	Concentrating Solar Thermal	1
28. Developer & Community partnership	Solar PV	5
29. Developer & Community partnership	Bioenergy	0
30. Developer & Community partnership	Waste to Energy	0
31. Crowd-funding	Solar PV	0
32. Energy performance contract	Solar PV	1
33. Energy performance contract	Solar Hot Water	0

Table 30: Business tally process results

Delivery Model	Technologies	Interested in pursuing (star top 5)
BUSINESSES AS OWNERS		
1. Private (business)	Solar PV	6
2. Private (business)	Solar Hot Water	
3. Private (business)	Small Wind	
4. Bulk buy	Solar PV	4
5. Bulk buy	Solar Hot Water	1
6. Community ownership	Solar PV	3
7. Community ownership	Bioenergy (Anaerobic Digestion)	2

DEVELOPERS AS OWNERS		
8. Private (developer)	Bioenergy (Anaerobic Digestion)	
9. Private (developer)	Waste to Energy (Advanced Gasification)	
10. Private (developer)	Solar PV	3
11. Council partnership with Energy company	Bioenergy	2
12. Council partnership with Energy company	Waste to Energy (Advanced Gasification)	1
13. Developer & Community partnership	Solar PV	2
14. Developer & Community partnership	Bioenergy (Anaerobic Digestion)	1
15. Developer & Community partnership	Waste to Energy (Advanced Gasification)	1
BUSINESSES OR DEVELOPERS AS PARTICIPANTS		
16. Energy performance contract	Solar PV	3
17. Energy performance contract	Solar Hot Water	
18. Leasing	Solar PV	5
19. Crowd-funding	Solar PV	2
20. Community (donation)	Solar PV	
21. Community (donation)	Solar Hot Water	
22. Community (donation)	Small Wind	
23. Rural/Urban	Large Wind	2
24. Rural/Urban	Solar PV	2
25. Rural/Urban	Bioenergy	
26. Rural/Urban	Concentrating Solar Thermal	2
BUSINESSES OR DEVELOPERS AS ADVOCATES		
27. Private (residential)	Solar PV	1
28. Private (residential)	Solar Hot Water	2
29. Council ownership	Solar Hot Water	
30. Council ownership	Solar PV	2
31. Council ownership	Bioenergy (Anaerobic Digestion)	2
32. Council ownership	Waste to Energy (Advanced Gasification)	
33. Council ownership	Small Wind	

E.2 MULTI-CRITERIA ANALYSIS

A multi criteria analysis in this context supports a decision making process, by providing an assessment of a range of options (technology/delivery model combinations) against a range of different criteria. For the purpose of the *Our Energy Future* project, the multi-criteria analysis (MCA) outlined below was designed to facilitate discussion within the stakeholder workshop and Steering Committee to help determine which of the options should be prioritised. Within the scope of the *Our Energy Future* project five priority technology/delivery model combinations will be economically costed. Given that there are 36 technology/delivery model options, the MCA process is designed to help identify which of these it would be most useful to cost and pursue further.

Multi-criteria analysis method

For this multi-criteria analysis process, where the delivery model and technology combination options have already been generated by ISF there are broadly five key steps:[39]

1. Select decision making criteria
2. Assess the performance of each option for each criteria
3. Assigning weightings to each criteria
4. Generate a total weighted score for each option
5. Examine results, refine the process and generate recommendations

Step 1: Select criteria

The criteria for the MCA are both qualitative and quantitative. The principles by which the criteria proposed have been selected are as follows:

- **Contextual**: The criteria need to have relevance to the context of the problem and the analysis at hand, i.e. in this case only criteria that matter in the context of renewable energy service delivery should be considered.
- **Discerning**: The criteria should distinguish between options i.e. if all options score the same, then the criteria is not meaningful in the analysis. Where options score similarly on a criterion, but the path matters, then the criterion should be modified to reflect the path i.e. to reflect the dimension that matters.
- **Assessable**: The criteria should be operationally meaningful i.e. that the performance of options can be assessed, either quantitatively through physical measures or qualitatively through judgment.
- **Consequential**: The criteria must focus on the consequences of each option.
- **Independent**: Double counting is to be avoided e.g. by not counting both reductions in GHGE and renewable energy generation
- **Life cycle oriented**: Each criteria should consider the whole life cycle of options and/or whole timeframe of decision making. Consistent boundaries are to be applied for each of the criteria across all the options and suites of options.
- **Distinguishable**: The criteria should be sufficiently different to allow for a useful comparison between pairs of criteria.
- **Agreed**: The criteria need to be true to the needs of council, community and business members of SSROC.

[39] Note this MCA methodology section draws from Ison (2009)

The table below describes the draft selection criteria and how each can be measured. Criteria where appropriate were adapted for each workshop to reflect the expected interests of the target stakeholder audience. For example ‘lower electricity bills for council’ was a criterion in the council workshop, while ‘lower electricity bills for households’ was a criterion in the community workshop.

Table 31: MCA critiera descriptions and measurement methods

Draft Criteria	Criteria Description	How to Measure
Annual energy production (MWh)	Measure of all annual energy production or equivalent due to the option	Estimate of direct energy (MWHe/year) from the option using the capacity factor and power capacity of each option in ISF’s D-CODE model
Peak demand reduction (kWp)	Measure of average daily peak demand reduction due to the option	Estimate of peak demand reduction (kWp) from the option
Calculated difference between cost of RE energy and grid energy over the expected lifetime of the RE system	This criteria is a rough estimate of the financial performance of the option in comparison to business as usual	Calculate all capital costs of options, including capital replacement over the time period plus operation and maintenance and divide it by the total expected lifetime energy production of the option($/kWh) Determine the value of the energy that the option will be replacing (e.g. residential, business, wholesale). Subtract the levellised cost of energy for the option from the value of the energy it will be replacing
Ease of option	Complexity of technology, status of technology in the market place, complexity of service delivery model	Judgement of the ease of organising and implementing the option
Green equity	Vulnerable or marginalised communities, including households on low incomes, are expected to be disproportionately affected by climate change compared to more affluent communities (Marrickville, 2009), specifically in regards to ratios of essential services costs to household income. Government responses to these impacts also have the potential to be unequal. Local councils have a key role to play in achieving ‘green equity’, that is to target environmental initiatives to low income households that would	Judgement of the potential for achieving: decreased costs of essential services, improve community participation, revitalize low income urban areas. Those options that would help achieve these things were given a score of 100, while those that had no discernable impact on these things were given a score of 50. Note: As the options are still quite high level, the detailed

	normally have the least capacity to take advantage of such initiatives, given that they are close to the communities they serve (Marrickville, 2009).	design of the options could seek to maximise green equity. This may mean, for example, partnering with Housing NSW to be a partner in the delivery model.
Decreased energy bills for business	This criteria is a yes no (0 or 100) criteria based on whether the combination option would reduce business electricity bills if installed appropriately.	Judgement based on financial flows associated with the technology and preliminary costing analysis
Decreased energy bills for households	This criteria is a yes no (0 or 100) criteria based on whether the combination option would reduce residential electricity bills if installed appropriately.	Judgement based on financial flows associated with the technology and preliminary costing analysis
Decreased Council Energy Bills	This criteria is a yes no (0 or 100) criteria based on whether the combination option would reduce council electricity bills if installed appropriately.	Judgement based on financial flows associated with the technology and preliminary costing analysis
Dividends to business or community	This criteria is a yes no (0 or 100) criteria based on whether the combination option provides business or community the opportunity to invest in a system, which if installed appropriately would yield a financial dividend.	Judgement based on financial flows associated with the technology and preliminary costing analysis

In addition to the criteria identified by ISF, stakeholders were invited to identify additional decision making criteria. Table 32 lists the new criteria identified by stakeholders.

Table 32: Criteria identified through stakeholder workshops

Community Workshop	Council Workshop	Business Workshop
Proven Success in Australia Ease of distribution to community from option Reliability (lifespan, long-term) **Acceptability by community** Community/commercial balance Perception of global environmental benefits (green dividend) Grid independence/connection Waste reduction (cost, volume)	Proven Success in Australia **Coverage across Councils/takes advantage of SSROC as a partnership organisation** Delivery Model that would only work at a partnership scale (cut out middle man) Systemic impacts Able to start soon Commercial availability of technology in Australia (with technical support)	Environment Concern/Action Reliability Ease of maintenance Life Time Durability **Grid Potential to Accept Power** **Reduced peak energy demand** Voltage Optimisation Return on Investment Payback period Proven to overcome barriers

Localised generation Storability of energy Community control Viability of option regardless of government policy **Solves other council issues e.g. waste**	**Quantum of investment/upfront cost for council** Return on Investment Ease of implementation Ease of Technology	

Step 2: Assess the performance of each option
For each of the original criteria (Table 31) the performance of each option is determined and a performance matrix compiled. For the quantitative criteria the performance is drawn from the D-CODE analysis while the qualitative performance is based on ISF expert judgment.

To compare the performance of options across different criteria there are a number of techniques. The one used here is linear additive approach which combines the performances of an option across all criteria into one overall value. This entails assigning a comparable score to each of the values in the performance matrix. To do this a scale is constructed- the most preferred option is given a score of 100 and the least preferred is assigned a score of 0, while the remaining options are assigned a score in-between, relating to the strength of preference (DCLG, 2009). The standardized performance (0-100) of each renewable energy/delivery model option for each criteria is given in Table 35: MCA Matrix.

A select number of the stakeholder identified criteria were chosen and the combination options that scored well in the first round of MCA and tally processes were scored qualitatively against each criterion. Specifically, Table 33 scores the top 10 options against additional criteria using ISF's judgement, where 5 = performs very well, 1= performs very poorly, n/a = not applicable criteria to that option/neutral/no impact.

Table 33: Performance of top performing combination options against selected stakeholder identified criteria

Combination Option	SSROC Scale	Upfront cost	Grid Potential to accept power	Peak demand reduction potential	Acceptability to community	Addresses other council issues
Solar PV - Leasing (residential)	3	4	2	3	5	n/a
Solar PV - Bulk Buy	3	4	2	3	5	n/a
Solar PV - Community Ownership	3	3	3	4	5	n/a
Solar PV - Council Owners	1	2	4	4	5	n/a
Solar PV - Council Backed Environmental Upgrade Agreements	4	2	3	4	5	n/a
Solar PV – Energy Performance Contract	2	4	3	4	5	n/a

Bioenergy (anaerobic digestion of food waste) - Council Partnership with an Energy Company	5	1	4	5	4	5
Waste to Energy (advanced gasification) - Council Partnership with an Energy Company	5	1	4	5	2	5
Large Wind - Urban Rural	4	2	4	1	3	n/a
Solar Hot Water for Pools – Council Owners	3	3	5	4	5	3

Step 3: Assigning weightings to criteria

The second element of the linear additive approach involves assigning a weighting to each criteria. Workshop participants were invited to weight each criteria out of 5 (5=top priority, 1=lowest priority. The results of this process are given in Table 34.

Table 34: Stakeholder Workshop Criteria Weighting Results

Council	Energy Production (MWh)	Difference between LCOE and export price	Ease of option		Green Equity	
	4.8	4.2	3.6		3.3	
Community	Energy Production (MWh)	Difference between LCOE and export price	Dividends from renewable energy projects to community members	Ease of option	Green Equity	Decreased energy bills for community members
	4.7	3.4	3.3	3.5	3.5	4.0
Business	Energy Production (MWh)	Difference between LCOE and export price	Dividends from renewable energy projects to businesses		Green Equity	Decreased energy bills for businesses
	3.3	4.2	3.6		2.8	5

Step 4: Generating a total weighted score for each option

The weighted score (S_i) for each option (i) is generated by Equation 1 which combines the performance scores from Step 3 (s_{ij})and the criteria (j) weights from Step 2 (w_j). The weighted score of each renewable energy/delivery model option is given in Table 35: MCA Matrix.

Equation 1

$S_i = w_1 s_{i1} + w_2 s_{i2} + ... + w_n s_{in} = \Sigma w_i s_{ij}$

Step 5: Examining the results and generating recommendations

This process includes, discussing the outcomes of the MCA and generating recommendations for ways to move forward, essentially wrapping up the process and ensuring that it has been useful. This process was undertaken through the Report Review, stakeholder workshops and a follow up meeting with the project Steering committee. At the Steering Committee meeting, ISF presented a synthesis from the prioritisation process, these were discussed and after much deliberation a top five were chosen for economic modelling, with a further three included for further analysis.

Table 35: MCA Matrix

Delivery Model	Technologies	Elec cost/price difference	Energy Production	Ease	Green Equity	Decreased business bills	Decreased community bills	Decreased council bills	Dividends to business or community	Council Score	Council Rank	Community Score	Community Rank	Business Score	Business Rank
Bulk buy	Solar Hot Water	79	18	80	50	100	100	0	0	35.3	17	40.4	5	41.2	6
Bulk buy	Solar PV	76	100	80	50	100	100	0	0	54.4	2	53.0	3	51.6	1
Community (donation)	Small Wind	0	0	60	50	0	0	0	0	10.8	31	12.9	32	5.6	33
Community (donation)	Solar Hot Water	79	18	60	50	0	0	0	0	31.8	19	24.8	20	21.3	26
Community (donation)	Solar PV	82	41	60	50	0	0	0	0	37.7	12	28.6	15	24.7	16
Community ownership	Bioenergy (Anaerobic Digestion)	87	2	20	100	0	0	0	100	22.3	28	24.4	21	26.1	13
Community ownership	Solar PV	82	41	60	100	0	0	0	100	37.7	12	34.5	7	30.3	9
Council ownership	Bioenergy (Anaerobic Digestion)	87	2	40	50	0	0	100	0	25.9	25	20.8	28	20.5	28
Council ownership	Small Wind	0	0	60	100	0	0	100	0	10.8	31	18.8	30	11.2	32
Council ownership	Solar Hot Water	100	2	80	50	0	0	100	0	36.0	16	27.0	18	22.7	22
Council ownership	Solar PV	82	41	80	50	0	0	100	0	41.3	5	31.0	10	24.7	16
Council ownership	Waste to Energy (Advanced Gasification)	90	13	40	50	0	0	100	0	29.2	22	22.8	25	22.4	23
Council partnership with Energy company	Bioenergy	87	2	60	50	0	0	100	0	29.5	21	23.1	24	20.5	28

Council partnership with Energy company	Waste to Energy (Advanced Gasification)	90	13	40	50	0	0	100	0	29.2	22	22.8	25	22.4	23
Crowd-funding	Solar PV	82	41	40	100	0	0	0	100	34.1	18	32.2	8	30.3	9
Developer & Community partnership	Bioenergy (Anaerobic Digestion)	87	2	20	100	0	0	0	100	22.3	28	24.4	21	26.1	13
Developer & Community partnership	Solar PV	82	41	80	100	0	0	0	100	41.3	5	36.9	6	30.3	9
Developer & Community partnership	Waste to Energy (Advanced Gasification)	90	13	20	100	0	0	0	100	25.6	27	26.4	19	28.0	12
Energy performance contract	Solar PV	82	41	80	50	100	0	100	0	41.3	5	31.0	10	44.7	2
Enviro' Upgrade Agreement	Solar PV	82	41	80	50	100				41.3	5	31.0	10	44.7	2
Leasing (residential)	Solar PV	76	100	40	100	0	100			47.2	3	54.3	2	37.2	7
Leasing (business)	Solar PV	77	41	60	50	100	0	100	0	36.6	14	28.0	16	43.8	5
Private (business)	Small Wind	0	0	60	50	100	0	0	0	10.8	31	12.9	32	25.6	15
Private (business)	Solar PV	82	41	80	50	100	0	0	0	41.3	5	31.0	10	44.7	2
Private (developer)	Bioenergy (Anaerobic Digestion)	87	2	40	50	0	0	0	100	25.9	25	20.8	28	20.5	28
Private (developer)	Solar PV	82	41	80	50	0	0	0	100	41.3	5	31.0	10	24.7	16
Private (developer)	Waste to Energy (Advanced Gasification)	90	13	40	50	0	0	0	100	29.2	22	22.8	25	22.4	23
Private (residential)	Solar Hot Water	79	18	100	50	0	100	0	0	38.9	11	42.7	4	21.2	27
Private (residential)	Solar PV	76	100	100	50	0	100	0	0	58.0	1	55.4	1	31.6	8
Rural/Urban	Bioenergy	87	2	20	50	0	0	0	100	22.3	28	18.5	31	20.5	28

Rural/Urban	Concentrating Solar Thermal	69	49	20	50	0	0	0	100	29.8	20	23.8	23	23.6	20
Rural/Urban	Large Wind	73	49	80	50	0	0	0	100	41.4	4	31.2	9	24.3	19
Rural/Urban	Solar PV	64	49	60	50	0	0	0	100	36.1	15	28.0	17	22.9	21

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