

CORPORATE ENERGY PLAN

City of Fremantle



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PREPARED FOR	City of Fremantle
PROJECT TITLE	Corporate Energy Plan
DATE	September 2017

PROJECT NO. 1707

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DATE OF ISSUE	REVISION NO.	REASON FOR ISSUE	AUTHOR	REVIEWED BY	Client
27/4/2017	Prelim.	This structural draft has been issued to provide an indication of the intended report format AND to establish an understanding with the City on the language and objectives of the Plan.	CE/MT	GP	MT
10/5/2017	Interim	Structural Draft revised based on comment from CoF (AS)	CE/MT	GP	MT
12/07/2017	First	Draft for client review	CE/MT	MT	AS
28/7/2017	Issue	Final draft delivered to client	CE/MT	MT	AS
24/08/2017	Revised	Interim revised draft for further review	CE/MT	MT	AS
25/08/2017	Revised 2	Second Interim revised draft for further review	CE/MT	MT	
04/09/2017	Final	Proposed for adoption by council	CE/MT	MT	AS
11/9/2017	Final	Removed "Commercial in Confidence" banners	MT	-	-

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1 Executive Summary

This plan proposes an achievable pathway for the City of Fremantle to move to running all corporate operations on 100% renewable electricity prior to 2025.

The pathway is designed to have minimal financial impact on the City of Fremantle, and shows how green energy can be procured at competitive rates. Initiatives that have a capital cost are only proposed if they have a strong, positive net present value. Options for alternative funding of the capital costs are discussed.

Simply put, the Plan includes the following strategies, all of which have detailed sections within this report that need to be reviewed for a complete understanding of what is proposed:

1. Introduce an Annual Energy Report that introduces consistent reconciliation of energy data.
2. Create a 'contestable' portfolio through the consolidation of the City's energy accounts, enabling the City to negotiate a single supply arrangement covering all City sites. Good progress has been made with Western Power and Synergy on this however further discussion between City Staff and the utilities will be required. The status of discussions is clearly outlined in the Report. Regardless, the Electricity Market Reform process that began under the previous State Government, is expected to result in full contestability with a few years, meaning that this approach will become a reality during the term of this Plan.
3. Based on the portfolio arrangement, negotiate with Western Power and Synergy for multiple sources of production/ consumption to be interconnected and reducing the costs for all users. This could also provide an energy cost advantage to local businesses. This idea is under consideration by Western Power and Synergy and will require further negotiation to complete.
4. Continually reduce energy consumption in buildings: Introduce regular energy audits and a mechanism to incentivise efficiency projects.
5. Maximise local renewable production without increasing the City energy costs. This may involve the City becoming the anchor customer that enables a new renewable energy project to be developed. We have obtained an offer from Alinta Energy that would allow the City of Fremantle to source all their electrical energy from renewable sources from 2017 onwards. This is for evaluation by the City.
6. Rooftop solar will not be sufficient to cover the City electricity load, so sourcing green energy from an external provider, but from a known project, preferably in the Fremantle area, is recommended. If the external green energy supply is cost effective, then rooftop solar may not be the best option, particularly given the ongoing management load that is added.
7. Upgrade traditional street and park lights to LED. Western Power is adding LED options to their catalogue and options for all existing lights should be available before the end of 2017. Despite the capital cost, the operational cost savings are expected to far outweigh the costs of financing the project. The bulk replacement of the traditional street and park lights with LED can be externally financed, and there are precedents for municipalities raising finance for such projects.
8. Continue to migrate the fleet to Hybrid Electric Vehicles. Set an emissions-per-kilometre target. Identify a point for introducing battery only vehicles, based on wider acceptance of the technology.

The following figure shows the changing energy profile (Consumption) and supply mix (Production) for the City of Fremantle over the period of the Plan.

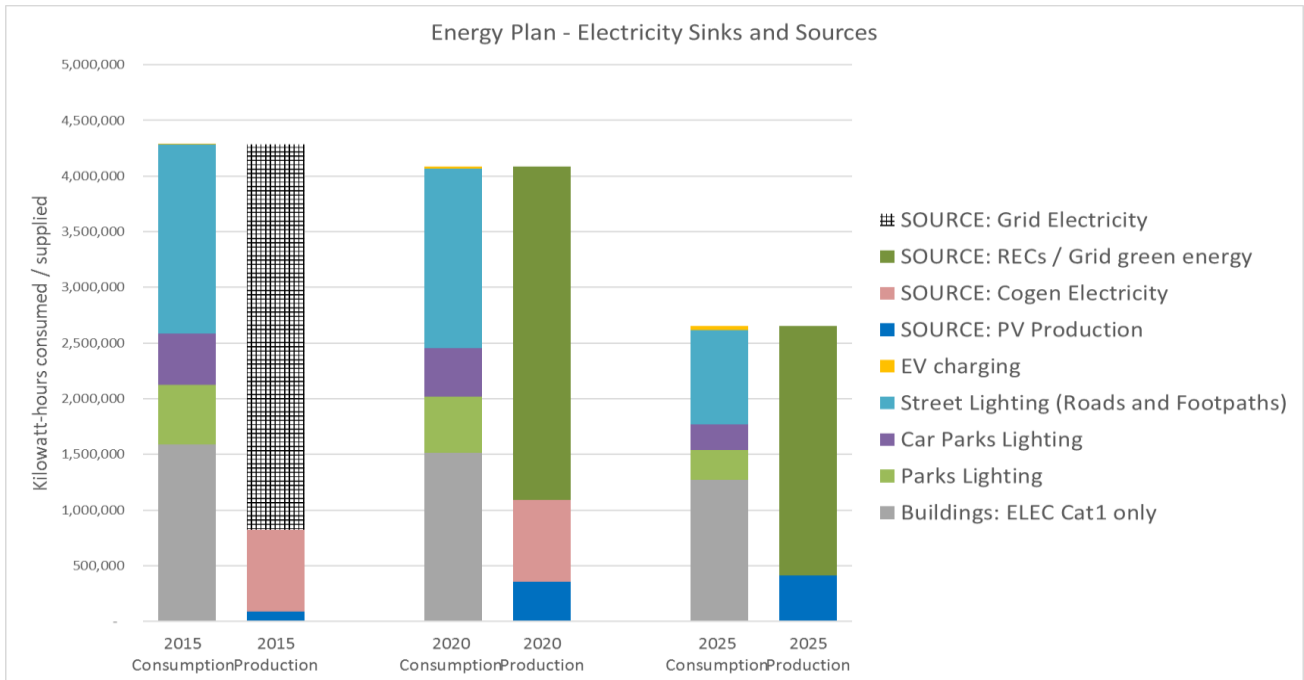


Figure 1: City of Fremantle - Forecast energy profile evolution over the period of this Plan

It is important to note that solar photovoltaic systems on City rooftops are not expected to meet the City's energy requirements, neither per building nor in total, so additional sources of renewable energy must be identified to meet the aim of this Plan. This additional source is referred to as RECs / Grid Green Energy, RECs being 'renewable energy certificates' (see section 10.8.8(a)(i)).

1.1 Indicative Cost Savings

Table 1 below indicates the scale of financial savings possible if a selection of initiatives are pursued by the City. These are savings based on case studies of similar projects completed in Australia and the UK. These figures are presented advisedly, acknowledging that varying amounts of work and capital outlay are required to achieve these savings. See the relevant recommended Management action for detail in Section 10. The *Estimated Certainty* column shows how closely related the relevant case study is to the City of Fremantle context, and hence how reliably similar results can be forecast.

There are opportunities, identified in this report (see section 8), to find external funding to assist in implementing any of these initiatives.

Table 1: Potential cost savings from energy projects

Item	Indicative cost	Short/medium or long term	Estimated Certainty	Potential cost savings per year based on 2016 figures	Potential discounted cost savings at 5% & free cash flow inflation of 2%
Streetlights and Park Lighting – energy efficiency – Discounted over 20 ¹ years.	\$5M	Medium term	75%	\$412,775 ²	\$6,174,574
Estimated demand side efficiencies - Buildings	\$460,000	Short term	50%	\$88,000 ³	\$752,910
Estimated Net Savings (weighted for certainty)				\$353,581	\$5,007,386

2 Priorities for implementation

This section outlines the priorities for implementation with consideration to the yearly budget constraints for the City.

2.1 Implementation of the Plan

Implementation of this Plan will depend on City processes and budgeting. However, notional target dates are set to match the timeline objectives originally set by the City.

- **October 2017** – Plan Delivered
- **Stage 1:** A contract is in place to procure green energy through one of the mechanisms described in the Plan, improvements to energy monitoring substantially advanced, any procurement and sustainability policy changes in place, and a mechanism to share energy between City sites has been advanced to the point that the initiative can either proceed or not. The first Energy Report is delivered in concert with financial reporting, and this report includes an appendix explaining the status of implementation of the Corporate Energy Plan. The process for moving the City street lighting mix to LED has been mapped and any costs to the City identified for budgeting. The fleet emissions footprint is well understood and is being offset through a credible scheme.
- **Stage 2:** renewable energy installations completed subject to finance, i.e. any viable rooftop PV systems have been installed, or a plan to install them as budget becomes available exists, and a

¹ 20 years as this is the estimated life of one LED bulb. Existing bulbs are replaced every 4-5 years so the maintenance cost savings are significant. Western Power will finalise the warranties later this year. Currently there are no official warranties.

² Estimate of 50% cost savings on current costs. Comparable projects are in the range of 60-70% of energy and maintenance cost savings. Western Power is currently approving suitable LED fixtures for WA, due late 2017. Synergy needs to publish new tariffs for these new LED fixtures due early 2018. Cost saving calculation can be updated in 2018 based upon the future tariffs.

³ Energy efficiency projects in older buildings are generally able to achieve 20-30% reductions. Not all buildings will achieve this in the period of the Plan, so a more moderate overall reduction has been used.

contract exists to procure the remaining electricity through one of the mechanisms described in the Plan. A street lighting upgrade plan has been initiated.

- **Stage 3:** Category 1 buildings are 100% renewable electricity on an annual average, with energy production shared between City sites (through a 'netting-off' approach, if this has been negotiated, or simply by arrangement with the retailer. The street lighting upgrade plan has been implemented and some upgrades completed. The fleet has been replacing vehicles with lower emission options, and the overall average emissions per kilometre of the City fleet is reducing, with a forecast for meeting the agreed benchmark.
- **Stage 4:** Sufficient renewable energy sourced to meet all corporate electricity requirements on an annual average. Gas and transport fuel use is optimised and offset through a credible scheme. Robust annual energy reporting is supported by regular energy audits and continuous improvement. A new era of the energy sector will have begun and the City of Fremantle will be in an optimal position to be part of it.

The following section features summary tables for each of the recommended Management Actions. The detailed information on each Management Action is in section 10.

2.2 Stage 1 Implementation - Workload

The Stage 1 recommendations of this Plan are focussed on governance improvements – reforming data collection and reporting, simplifying accounts, identifying sources of funding and putting audit processes in place. This process is likely to yield benefits in uncovering unnecessary expenditure (e.g. gas accounts that attract fixed costs but do not need to be kept open), and in simplification (e.g. Synergy may be able to provide sufficient reporting to significantly downsize the service currently being provided by third party data managers, reducing the annual cost). It will also position the City to make further decisions, mapped out in this Plan, with high levels of confidence about the business case, and embed auditing in to the way energy, and innovation, is managed.

To achieve these positive outcomes a focussed period of implementation is required, ensuring that the various Management Actions are progressed in a coherent, integrated way. This would best be achieved through creating a role, possibly temporary, of 'Energy Officer'. Someone with building energy audit experience would be ideal, as well as with some rudimentary understanding of carbon accounting. A graduate of 'Sustainable Energy Management', or similar degree course, may be suitable.

Over a six-month period, this officer would oversee the implementation of:

- Annual Energy Plan, with associated reform of data gathering.
- Review of the data management service, and finalise changes for a more effective service.
- Building Energy audits, to be embedded with the Building Audit process.
- Review of FLC cogeneration system performance against the original business plan and recommend a course of action.

- Review of gas accounts.
- Creation of a City of Fremantle Energy Portfolio, in whatever form has by then been enabled by Western Power and Synergy/retailer.
- Support role in negotiating the new green energy electricity contract for the City supply.
- Liaise with relevant officers on implementation of the Energy Plan, identifying and escalating any barriers to implementation.
- Compile the first *Energy Plan Status Update* for inclusion in the first *Annual Energy Report*.

The Energy Officer role would best report through the 'infrastructure projects' group, or equivalent, as they will be the key users of the information that is unlocked.

2.3 Proposed Management Actions - Summaries presented in staged implementation

The following tables are presented according to recommended staging. Each table is a summary of the Management Actions that are detailed in section 10.

2.3.1 Stage 1

Action	Annual Energy Report	Energy Plan Status Update
Final Recommendation	Create an Energy Report that is a standard element of the City's annual reporting, and requires that energy data be reconciled with financial data annually.	Create an Energy Plan Status Update report for the period of the Plan to 2025. Issue this as an appendix to the Annual Energy Report.
NPV / LCoE	na	na
Renewable Energy (kWh/year)	na	na
Emissions (+/- Tonne CO2e/year)	na	na
Leadership value	Transparency and governance	Transparency and governance
OPL impacts	OPL's overall philosophy is around continues improvement, which requires monitoring and reporting.	OPL's overall philosophy is around continues improvement, which requires monitoring and reporting.
Plan Stage to implement	Stage 1	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. •Data reform: The structure of the report will require a regular reconciliation of energy data to financial data. 	<ul style="list-style-type: none"> • Annual Energy Reports: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. •All actions: All agreed Management Actions to be reported on.

Action	Energy Portfolio	Fremantle Leisure Centre – Energy Systems
Final Recommendation	<p>1)Resolve with Synergy and Western Power whether the City Electricity accounts can be amalgamated and treated as a single, contestable portfolio.</p> <p>2)Resolve with Synergy whether ‘netting-off’ between sites can be enabled. Western Power have confirmed they will not charge for transferring power between sites behind the meter. Synergy has still to confirm their position.</p> <p>3)Resolve with Western Power whether PV systems on City facilities can be pre-approved en-masse.</p>	<p>Apply to connect the existing FLC PV system. Engage an experienced PV contractor to assist.</p> <p>Complete a full audit of the last year of operation of the geothermal/cogen system to determine performance, and assess the real value of the system.</p>
NPV / LCoE	TBC	TBC – unknown until the outcome of the PV connection application, and any resulting costs are known. Value of energy produced will be approx. \$10K per year.
Renewable Energy (kWh/year)	na (these are platforms, rather than energy generation)	49,000 kWh
Emissions (+/- Tonne CO2e/year)	na	-40 Tonne CO2e/year (compared to grid power)
Leadership value	This approach would be of strong interest to LGAs with non-contestable sites.	High given the high visibility of the system.
OPL impacts	General compliance OPL’s principles around better management of resources.	OPL’s overall philosophy is around continuous improvement, which includes maintenance and ongoing commitment to outcomes.
Plan Stage to implement	Stage 1	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> •Amalgamating accounts could impact the deal making leverage with a green energy supplier, by increasing the total load being met. •The ability to nett-off excess generation at a site could change the decision on PV system sizing at a given site. •A simplified approvals process for City PV systems could impact the commercial decision making on viability of a given PV system. •The en-masse approvals process could enable the FLC PV system back online, although this is far from certain. 	<ul style="list-style-type: none"> • Annual Energy Reports: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. •Energy Account Portfolio: ‘netting-off’ may impact the requirement for zero-exports.

Action	Energy Efficient Buildings	Local Renewable Energy Supply
Final Recommendation	<p>Add energy auditing to the Building Audit process.</p> <p>Create an Energy Check process from tradespeople on City sites.</p> <p>Develop building type energy consumption benchmarks with WALGA and others.</p> <p>Develop a game layer for different facilities to compete on energy performance, incentivised by a share of the savings or similar. Competition between LGAs could also be supported by WALGA.</p>	<p>Obtain a range of quotes from green energy supply including: Greenpower from Synergy, Greenpower Connect from Alinta to set price benchmarks.</p> <p>Negotiate a supply arrangement with a local green energy project that can be enabled by the City's account.</p>
Financial value	Saving \$80,000 per year by 2025, costs estimated \$480,000 over that period.	It is expected that green energy can be found for the same price as is currently being paid for black power plus offsetting.
Renewable Energy (kWh/year)	10-20% building energy (approx. 400,000 kWh/year)	2,100,000 kWh
Emissions (+/- Tonne CO2e/year)	-400 Tonne CO2e/year	-1,720 Tonne CO2e/year
Leadership value	Reduce waste of energy	Enabling a renewable energy project, achieving target.
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓]	Zero Carbon (100% renewable energy) [✓ ✓ ✓]
Plan Stage to implement	Stage 1	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> - Energy Plan Status Updates: progress on creation of the necessary documents and changes to procedures to be recorded in the Energy Plan Annual Report - Annual Energy Report: This report will have a section dedicated to recording which buildings have been audited, which Energy Checked, and what opportunities for energy efficiency were identified. This section should also note how many audits and checks were carried out in the previous reporting period. - Data reform: part of the audit process will be to align meter and account numbers to buildings, and check that consumption data is being collected correctly. 	<ul style="list-style-type: none"> •Energy Plan Annual Reports: Green energy use to be tracked - City PV Systems: The amount of green energy purchased is dependent on the scale of renewable energy systems installed by the City.

Action	Gas Accounts
Final Recommendation	Review the gas accounts. If the accounts are no longer needed then disconnect and save money on connection fees.
Financial analysis	Savings on unnecessary account charges where the gas connection is not required.
Renewable Energy (kWh/year)	na
Emissions (+/- Tonne CO2e/year)	na
Leadership value	Fiscal management.
OPL impacts	na
Plan Stage to implement	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: report on closing of accounts and fixed charges saved.

2.3.2 Stage 2

Action	Street and Park Lighting Upgrades	City Owned Photovoltaic Systems
Final Recommendation	<p>1) Trial LED street lights (e.g. current Market St upgrade) and adaptive lighting, and report internally on lessons learned to inform a larger roll-out as more LED options enter the Western Power catalogue in the next year.</p> <p>2) Once Western Power release their updated catalogue of LED light options, Synergy can finalise their costs. Once this occurs then a complete replacement program of all lights with LEDs is recommended. The costs, payback period and financing can only be completed once the Synergy charges are finalised.</p>	Rooftop PV will not supply the majority of the City's electricity load. The financial value of rooftop PV must be assessed in the context of the solution that is negotiated to meet the majority of the City's load.
Financial value	Saving \$412,775 per year by 2025, or by the time all lights are changed over	14 cents/kWh (100% renewable energy)
Renewable Energy (kWh/year)	Na (energy saving estimated at 50% street lighting energy, approx. 1,000,000 kWh/year)	733,000 kWh
Emissions (+/- Tonne CO2e/year)	-820 Tonne CO2e/year	-600 Tonne CO2e/year
Leadership value	Reduce waste of energy, provide modern lighting system	Systems will be visible around the City
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓]	Zero Carbon (100% renewable energy) [✓ ✓ ✓] Sustainable Materials and Zero Waste [x]
Plan Stage to implement	Stage 2	Stage 2
Interaction with other Actions	<ul style="list-style-type: none"> - Lighting services could become part of the energy Portfolio Approach. - Renewable energy certificates may be required to address street lighting energy, and could be procured through the Local Renewable Energy Supply. 	<ul style="list-style-type: none"> - Energy Plan Annual Reports: PV system roll-out plan to be tracked - Data reform: PV data collection to be standardised and performance benchmarked - Local PV systems, Offset Strategy: The scale of other Actions is dependent on the scale of renewable energy systems installed by the City.

2.3.3 Stage 3

Action	Voltage Optimisation	Sustainable Corporate Transport
Final Recommendation	<p>VO should be considered for the new administration building as part of the base design.</p> <p>Providers should be contacted to review other buildings for VO viability.</p>	<ol style="list-style-type: none"> 1. Incentivise alternative transport choices. 2. Set targets for fleet emissions intensity. 3. Create regular reporting so that progress towards target can be tracked. 4. Enable electric vehicles through charging points and carpark design. 5. Identify vehicle types that are suitable to be procured as electric vehicles. 6. Identify opportunities to reduce vehicle size 7. Enable route efficiency 8. Consider bio-fuels, particularly bio-diesel for heavier vehicles. 9. Identify opportunities to incentivise lower emission choices through the novated lease / salary sacrifice system.
NPV / LCoE	Revenue positive at all times.	na
Renewable Energy (kWh/year)	Minimum 30,000 kWh per building	na
Emissions (+/- Tonne CO2e/year)	-25 Tonne CO2e/year	TBC Tonne CO2e/year [data currently available is not adequate for estimating emissions – a methodology has been provided]
Leadership value	To asset managers and building engineers	City hybrids and any BEVs should feature large signage communicating the benefits.
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓]	Zero Carbon [✓ ✓] (impact will be gradual) Sustainable Materials and Zero Waste [x] (more work on material reuse and recycling required in car industry)
Plan Stage to implement	Stage 3, and whenever a building transformer requires replacement	Stage 1 – 3 (ongoing, various initiatives)
Interaction with other Actions	<ul style="list-style-type: none"> •Building energy audits should include a pre-assessment regarding the total load and the state of the current building transformer. 	<ul style="list-style-type: none"> •Energy Plan Annual Reports: roll-out of low emissions transport options to be tracked •Data reform: Vehicle fuel and emissions data collection to be standardised and performance benchmarked <p>Increased EV use will increase electrical load. This has been allowed for in calculations of predicted load profile to 2025.</p>

3 Background

The City of Fremantle is committed to being a sustainable organisation, demonstrated by the City’s endorsement of the One Planet Strategy in 2014. In 2015, the City became the fourth council in the world and the first in Western Australia to achieve national certification as a One Planet Council.

Fremantle’s One Planet Strategy outlines corporate and community targets under ten principles of sustainability. The ‘Zero Carbon’ principle refers to the need for energy efficient buildings and power sourced via renewable technologies, with the aim of using 100% renewable energy by 2025.

3.1 Alignment to City Positions and Existing Plans

The City of Fremantle Corporate Energy Plan will sit alongside an existing set of plans and strategies, including:

- One Planet Living Action Plan
- Low Carbon City Plan.
- Climate Change Adaptation Plan
- DBH12 Energy Efficiency Building Design
- Local Planning Policy 2.2 Split Density Codes and Energy Efficiency and Sustainability Schedule

3.1.1 Strategic Community Plan

In reference to the Fremantle Strategic Community Plan⁴, this energy plan achieves the stated objectives of the City.

Table 2: Aligning the Strategic Community Plan and Corporate Energy Plan

Strategic Community Plan	Corporate Energy Plan
Outcome	Comments
All City controlled buildings, activities and public places will be more energy efficient and energy will increasingly be delivered by renewable technology.	<i>The Corporate Energy plan addresses increased building energy efficiency and increased renewable energy consumption.</i>
Objective	
• Continue carbon neutral status with less reliance on offsets.	<i>Our recommendations are based on maintaining carbon neutral status and works towards eliminating the need to purchase carbon offsets.</i>
• Promote building energy efficiency and deliver energy with renewable technologies.	<i>Our recommendations will result in reduced energy demand, greater efficiencies and higher penetration of renewable energy</i>
Measure of success	
• All buildings, structures (including street lighting and stationary energy sources), and activities within the operational control of the City of Fremantle will be ‘net zero carbon’ by 2025 with a substantially reduced reliance on offsets.	<i>Our recommendations would eliminate offsets and put the City buildings on the path to 100% renewable energy by approximately 2020, with the broader emissions footprint being reduced and offset to achieve zero net carbon by 2025.</i>

As a subset of the Strategic Community Plan, the vision and mission statements for energy could be summarised as;

Corporate Vision – Energy (proposed)

⁴ Ref: <http://www.fremantle.wa.gov.au/communityplan>

The City of Fremantle aims to be an energy conscious carbon neutral organization that continually seeks to minimise energy consumption while encouraging the development and implementation of renewable energy sources and sustainable infrastructure.

Corporate Mission Statement – Energy (proposed)

The City of Fremantle will develop and implement energy projects that deliver excellence in service while at the same time supporting current and future energy needs of the City in an economically, socially and environmentally responsible manner.

The City is looking to achieve an energy supply that is:

- Green: 100% renewable energy.
- Affordable: Achieving good value for money and not being penalised for choosing green energy sources.
- Reliable: An energy strategy that is consistent with City processes and avoids adding complexity in terms of governance or technology.

3.1.2 Energy plan 2016

The Corporate Energy Plan became a City of Fremantle project in January 2016⁵, with the following objectives:

The City of Fremantle is committed to making buildings more energy efficient and sourcing all energy requirements from renewable technologies. This reduces the City's greenhouse gas emissions, contributing to the federal government carbon reduction targets. It also contributes to a more economically resilient City by reducing current costs and additional future costs associated with fluctuations in energy pricing. By committing to being a renewable city, the organisation is supporting the local renewable energy industry. By adding renewables to our community buildings, this City is also helping the community to reduce their running costs.

3.2 Background to the Western Australian Energy Market

The following discussion details the regulatory and technical limitations relevant to the City of Fremantle Corporate Energy Plan. Approaches to addressing these limitations are the subject of the Options Analysis section of this report, where a set of Management Actions is proposed that are either achievable within these limitations, or are designed to challenge them in a productive way.

3.2.1 Western Australia Electricity Sector Background

The sector is structured into three roles:

- Generators - create the electricity.
- Western Power - transports the electricity.
- Retailers - purchase electricity in bulk (wholesale from generators) and sell to customers.

⁵ <https://www.fremantle.wa.gov.au/energy-plan-0>

The structure that supports the wholesale purchase and sale of electricity between generators and retailers is the Wholesale Energy Market (WEM). Synergy is the largest retailer and the largest generator in the market. Within the WEM, retailers must purchase the following to meet their customers' requirements:

- Electricity – In each half hour a retailer must purchase enough generated electricity to meet its customers' metered requirements.
- Capacity Credits – A retailer must purchase enough generating capacity to meet its customers' peak demand requirements.
- Renewable Energy Certificates⁶ (RECs) – A retailer must purchase RECs to meet a defined percentage (increasing to meet a target of 20% by 2020) of its customers' loads, currently it is 14.22%. RECs currently come in two forms, Small-scale Technology Certificates (STCs) and Large-scale Generation Certificates (LGCs).

3.2.2 Regulatory Limitations

The regulatory environment in the West Australian energy sector currently presents material limitations to the efficient adoption of renewable generation, such as primacy of the network operator in connection approvals, and the barriers to market entry in retailing, and therefore implicitly also in generation. The largest material limitation is the requirement that connection points that have an expected consumption below 50 MWh per annum can only have Synergy as a retailer. This requirement is referred to as the contestability threshold and is implemented by a prohibition on Western Power connecting any load less than 50 MWh per year. The majority of the City's electricity load is at sites that are already contestable, but some connection points currently fall below the contestability threshold and therefore, currently, can only be supplied by Synergy. In a portfolio environment, where all generation and consumption are shared between all sites, all locations would be contestable when combined.

It is important to note that this restriction on contestability only relates to NETT CONSUMPTION locations. If locations are NETT GENERATION, meaning that they produce more electricity than they consume on average, then the restriction does not apply. Therefore, there is the incentive to make as many locations as possible net generation locations. This presents the question: what is the best price for this excess generation? Generally, using this excess generation to reduce additional power consumption elsewhere in the City of Fremantle's portfolio is likely to be the most economic option although there is also the possibility of selling this power to Synergy or another retailer. This approach can be referred to as virtual generation.

The virtual generation approach opens up several new possibilities. Potentially the City of Fremantle could become an energy retailer and sell excess energy to local companies, or potentially work with an existing retailer to develop this market. Overall this approach reduces energy costs for the City while also providing opportunities for new revenue streams. This is discussed further as a Management Action in the Options Analysis section.

The Australian Energy Market Operator (AEMO) and the new State Government is keen to remove these archaic restrictions that entrench Synergy's monopoly. Western Power is also very supportive of increased competition and contestability and has offered to assist and support the City of Fremantle in facilitating the microgrid/ portfolio approach.

⁶ The Renewable Energy Certificates are the result of Federal legislation.

3.2.3 Technical Network Limitations

Western Power is required to maintain the electricity supply within a defined range of technical parameters. Customers' electrical loads and generating equipment directly affect these parameters. As a result, Western Power must technically assess any significant changes to electrical generation facilities or loads via an engineering study funded by each party wishing to significantly change load or generation. This requirement will apply if the City of Fremantle wishes to install electrical generation on any site above 5kW. As part of this project, the City of Fremantle has initiated a pilot project and technical assessment with Western Power and Synergy.

3.2.4 Portfolio generation, Microgrid and Virtual Power Plant

These are concepts that each require some change to business-as-usual by the retailer or the network operator. The Following terms are often used interchangeably. For the purposes of this Plan, it is useful to define the terms.

(a) Portfolio (of Electricity Connections)

A portfolio approach is to consider all City accounts in one consolidated portfolio. Currently each location is treated separately. There are three aspects of the portfolio approach that could be beneficial. These are not inter-dependent. A barrier, or delay in achieving one does not compromise the others.

- 1) Consolidating all sites as 'contestable' so that the City can negotiate supply competitively for all sites, rather than just the larger consuming sites (although these larger sites account for the majority of total electricity consumption). *NOTE: requires a regulatory interpretation that may not be achievable.*
- 2) Allowing generation from one location to net off with another location within the portfolio rather than the generation just being limited to the physical location. This is, in effect, energy trading within the City sites. *NOTE: this has been discussed with Synergy and seems likely to be achievable.*
- 3) Simplification of Western Power approvals for PV systems – a general approval for all PV systems to be automatically approved on City sites up to a certain overall limit. This could simplify PV roll-out. *NOTE: this has been discussed with Western Power and they are receptive but the final arrangement will require a formal proposal from the City.*

(b) Microgrid

A "Microgrid is a localized grouping of electricity sources and loads that normally operates connected to and synchronous with the traditional centralized electrical grid, but can disconnect and function autonomously as physical and/or economic conditions dictate."⁷ This allows the integration of various sources of distributed generation, like solar PV or wind. Microgrids also provide greater redundancy, network robustness and flexibility in configuration. It may be that the City of Fremantle moves to a microgrid configuration as part of stage 2, potentially incorporating other locations not owned by the city, that is leased buildings or local businesses.

(c) Virtual Power Plant

Virtual power plant is a cloud-based or distributed control centre that takes advantage of information and communication technologies (ICTs) and Internet of things (IoT) devices to aggregate the capacity of heterogeneous Distributed Energy Resources such as solar PV, wind, batteries to form a heterogeneous Distributed Energy Resource for the purpose of energy trading in the wholesale electricity markets and/or providing ancillary services for system operators on behalf of non-contestable individuals. This can be considered stage 3 and is an extension of the portfolio and microgrid approach. This would require

⁷ Wikipedia

additional renewable generation and would likely include local businesses including the Fremantle Port Authority. The control systems to manage this are currently undergoing significant evolution and development. There are several local WA companies who are specialising in this approach.

These options are considered in the Recommended Management Actions section.

3.3 Applicable Renewable Energy Technologies

This section presents a general overview of renewable energy technologies, providing background on why some have been selected as more applicable than others to the City's needs. The City's energy needs are currently provided almost entirely from mains electricity, offset using carbon offsets to maintain the City's Carbon Neutral status.

This section provides background to the detailed, specific recommendations contained in the Options Analysis section.

3.3.1 Network Sourced Renewable Energy Options

(a) GreenPower

The GreenPower Program (the Program) is a government-managed scheme that enables energy users to displace their fossil fuel electricity consumption with certified renewable energy. According to GreenPower, the cost of their green energy is approximately 5-8 cents per kWh more than the standard current electricity rate. In discussions with the City of Fremantle it was indicated that cheaper alternatives for the same result is the preferred option.

NOTE: The Clean Energy Regulator annually publishes the Renewable Power Percentage (RPP) that must be included within the generators portfolio. In 2016, the Synergy RPP was 14.22%⁸, meaning that if, for example, a customer wanted to be using 100% renewable energy, then they would only need to purchase additional Greenpower to cover around 86% of their consumption. Compared to simply purchasing 100% Greenpower, this represents a 14% reduction on the additional cost.

For Fremantle, electricity used in 2016 was 4,100,333 kWh. Purchasing Greenpower at 8 cents per unit (the added cost on top of the regular tariff) would have been \$326,027 for the year. Reducing this by the 14.22% existing Greenpower in the mix, reduces the cost of going to 100% renewable by \$46,645 for the year. This saving only applies if the City seeks to meet the 100% renewable target through purchasing Greenpower, which is unlikely to be the most cost-effective approach.

(b) GreenPower Connect

A new product is called GreenPower Connect that allows the City of Fremantle to directly support the development of specific new renewable energy projects by purchasing the Large-scale Generation Certificates (LGCs) through direct contracts with the generator (via off take agreements). Based on discussions with Alinta, one option could be the Badgingarra windfarm although other retailers such as Synergy may have similar projects. The point of differentiation is the cost of energy compared to the standard GreenPower option. This is available now and would allow the City of Fremantle a lower-cost opportunity to directly fund new large renewable energy projects and move to 100% renewable energy. GreenPower Connect would allow the City of Fremantle to reap all the marketing and reporting benefits GreenPower has to offer, such as in increasing the NABERS rating and using the personalised GreenPower Connect customer logo on the City's marketing materials. This should be considered together with other renewable options such as the South Fremantle Solar Farm, the Fremantle Port Authority proposed PV system, or the proposed Fremantle Wind Farm at the port.

⁸ <https://www.synergy.net.au/Large-business/Manage-your-account/Pricing-updates>.

It should be noted that the idea of wind generators located near the port is not supported by the Port Authority.

Alinta has provided a GreenPower Connect offer for the City as part of discussions with them for compiling this Plan.

3.3.2 Levelised Cost of Electricity

Levelised Cost of Electricity (“LCoE”) standardises all types of generation to produce an average cost per unit. This allows diverse forms of generation to be compared over the lifecycle of the equipment. LCoE only includes the electricity costs of production and not profit, depreciation or taxes. The two main costs are fuel and operations & maintenance. Some cost components depend upon the technology, for instance solar and wind do not have fuel costs. There are variances across the generation calculations caused by variable costs such as load factors, discount rates and location. The LCoE values in the table below (Figure 2) were calculated on an Ex-works or Gate price basis that means all costs incurred until entering the grid are included. Carbon Capture and Storage (CCS) is an option but not mandated. Transmission costs are not included and can be significant depending upon location.

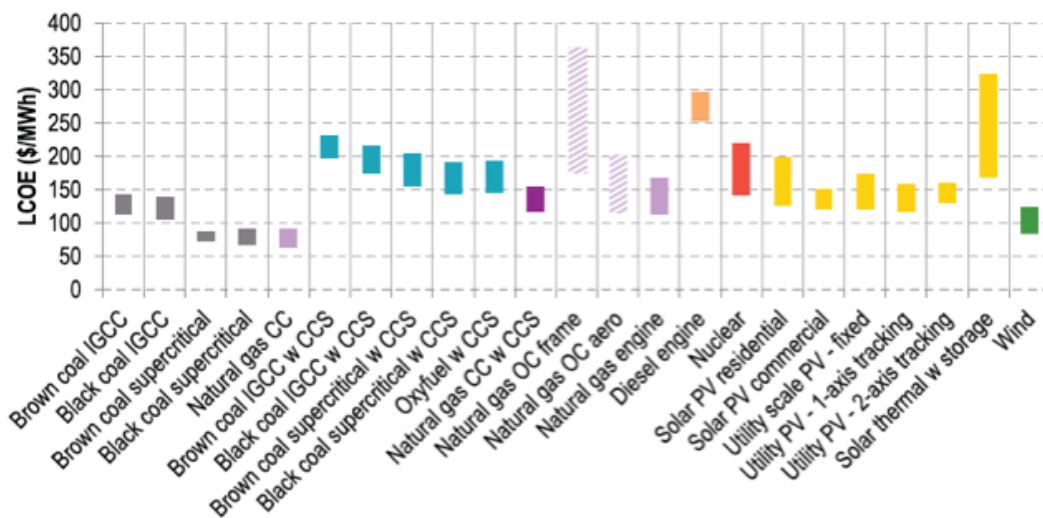


Figure 2: Levelised Cost of Energy, Generation Technologies⁹

Key to terms: IGCC = Integrated Gasification Combined Cycle, CC = Combined Cycle, CCS Carbon Capture and Storage, OC = Open Cycle, PV = Photo Voltaic

Above are the LCoE for the main forms of electricity generation in Australia in 2015. The cost of solar PV generation has decreased significantly in recent years and is competitive or cheaper than most other forms of generation. The following figure shows the projected movement in LCoE to 2050 for various generation technologies (Figure 3). The projections for price reductions in carbon capture and storage (CCS), as well as for solar thermal, should be read with CSIRO’s research investment in these technologies in mind.

⁹ Australian Energy Council: <https://www.energycouncil.com.au/analysis/what-next-for-integrating-wind-and-solar/>

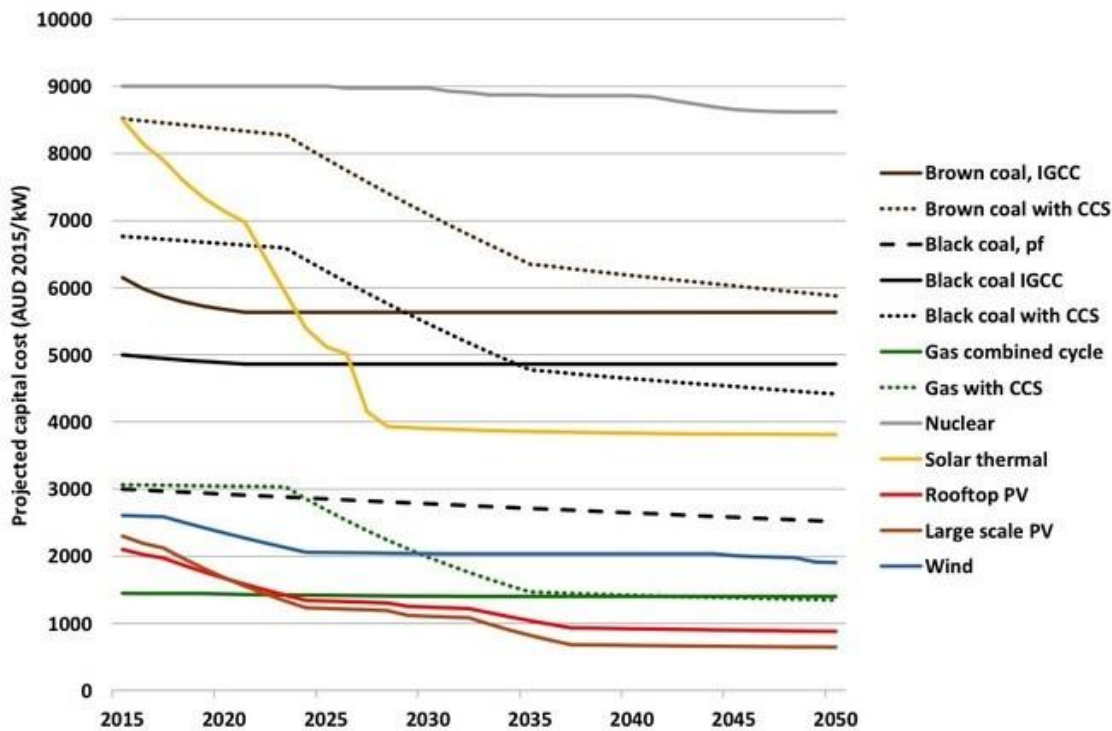


Figure 3: Levelised Cost of Energy trends¹⁰

This LCoE shows wind is the most economical of the renewable energies available however is intermittent and therefore should only be one generation option within a portfolio of generation to match current and future electricity demand profiles.

3.3.3 Onsite renewable energy options

A summary of the sources evaluated includes;

- Solar PV
- Bioenergy
- Waste to energy
- Wind
- Wave Energy

(a) Solar Photovoltaic (PV)

PV generation is now a major source of electricity in Australia. The technology is proven, as are the economics. There is little need to go into detail regarding this now very familiar technology.

There are various existing solar PV options such as:

- Solar PV on council buildings – part of the microgrid/ portfolio approach mentioned earlier

¹⁰ CSIRO: <https://blog.csiro.au/wind-solar-coal-gas-to-reach-similar-costs-by-2030/>

- South Fremantle Solar Farm – Depends on terms and pricing and requires evaluation on a project by project basis
- Solar Fremantle Port Authority – the Port has expressed an interest in developing a solar farm on their extensive rooftops. City of Fremantle electricity purchase could enable this project but the concept is at an early stage only.
- Solar projects – Non-metro. Power can be purchased through the GreenPower Connect program. Depends on terms and pricing and requires evaluation on a project by project basis.

PV is examined in more detail in the Section 10.8 and Section 10.9 of the Recommended Management Actions.

(b) Bioenergy

Biogas from waste and sewage is a mainstream technology although it is not widely implemented in Australia. Water Corporation advertises the need to recover resources from sewage, one resource being biogas. One recent international example has been in 2016 the Danish town of Aarhus began operating biogas energy production from their water treatment facility in Marselisborg. The required upfront investment was nearly €3 million, but Aarhus Water expect that to be recouped in just five years.¹¹

In Australia, Unity Water and Arena are converting Unitywater’s Kawana sewage treatment facility on the Sunshine Coast to generate biogas and electricity from a variety of waste sources. The total project cost is \$A697,000 and is one of the first in Australia. The Australian Water Sector Report identifies bioenergy in waste water treatment as an investment priority, highlighting the need to support activities that demonstrate the viability and overcoming barriers to co-digestion of different waste feedstocks for anaerobic digestion.

The City of Fremantle paid \$149,822 for sewage in 2016 with none of the benefits of resource recovery as these are captured by Water Corporation. To minimise costs but also provide the option to reduce costs, the City of Fremantle could potentially look at an EOI process for building, owning and operating a biogas plant using Fremantle sewage, if it is determined to be economic. This could be done in conjunction with Water Corporation with the City of Fremantle buying this renewable energy reducing costs as well as generating a new revenue stream from existing waste products. The EOI process would allow the private sector to determine the business case, introduce innovative technologies and potentially provide financing.

We spoke to Heather Bone, a Director of Bioenergy Australia, about bioenergy options for municipal waste. Her recommendation is that bioenergy from sewerage needs a minimum of 100,000 people to be feasible. It is important to understand the types of waste that are available and then determine which of the various technologies are suitable for that waste. There are multiple micro-generation options however this is a complex area that is outside the scope of this engagement. Essentially as the City of Fremantle has a strategic focus on this area, the City needs to identify the various waste streams, forecast volumes and quality and then review the technologies and options available in a methodical way.

While it is unlikely that the City will have an appetite for this kind of a system at this point in time, it is helpful to long term planning to begin to understand the value of waste streams as resources.

(c) Waste to energy

As per the Strategic Community Plan the City states that “At least 80% of the City of Fremantle residential

¹¹ <https://www.newscientist.com/article/2114761-worlds-first-city-to-power-its-water-needs-with-sewage-energy/>

waste will be recycled or reused by 2020.”

There are a variety of waste products that can be converted to energy through biogas, biomass or other forms of conversion. Each project needs to be considered on its merits as to whether the project is commercially viable. There are many issues around the quality, consistency and price of the waste products (fuel supply) as well as the true costs of operations and maintenance. No waste to energy projects were presented to us for review as part of this project. Although outside the scope of this report, the City would benefit from a methodology with which to evaluate waste to energy projects. There are many reasons why specific projects could be viable while either reducing costs or increasing revenues.

(d) Wind

Domestic wind turbines are available and can be installed throughout the City should the operator receive planning permission. Wind is generally not the technology of choice for energy generation in urban environments as it tends to be considerably more effective at large scale, and so not suitable for urban contexts. This is in part a mechanical fundamental: small turbines must spin relatively more quickly to achieve a useful power output, resulting in degradation of mechanical components such as bearings, and resultant derating and failure. There are also limitations around buildings and wind shadows, although a port city has the option of locating turbines on the coast, away from interference.

There is a long-held desire, through a series of proponents over the years, to see wind resources harnessed at Fremantle Port. Discussions with the Port in the development of this Plan were not encouraging of a local wind farm in their operational areas, or nearby.

(e) Wave Energy

Leading WA wave energy developers are Carnegie Clean Energy and Bombora Wave Power.

Fremantle’s Coastal location should make this an attractive technology however, in terms of timing, wave technology is only slowly emerging from the R&D phase into commercialisation and so is unlikely to be a viable option unless a wave energy developer brings a coherent offer to the City. Carnegie has a project in development at Garden Island, near Fremantle, which might be somehow expandable to allow the City to procure energy. To this end, the two leading WA developers have been contacted and any response will be passed on to the City.

3.3.4 Batteries

Battery storage is widely considered to be a solution to the intermittency of some renewable energy sources such as solar and wind. Storing energy also allows generators to use or release the energy into the market/grid where the economics are most favourable. It also reduces the need to purchase expensive electricity from the grid. The Climate Council¹² estimates in the coming years half of all households will install battery technology with their solar installation and will have a payback period of approximately 10 years. City of Fremantle sites are mostly commercial use, so they tend to have higher daytime loads, making storage slightly less attractive, hence the need for a detailed business case based on actual monitoring of the load.

There are many types of battery technologies, with the most common currently being chemical storage based on lithium batteries. Other power storage methods include compressed air, capacitive, electrochemical,

¹² Climate Council – Powerful potential: Battery storage for renewable energy and electric cars 2015.

thermal and mechanical. The City of Fremantle would focus on technologies from reputable suppliers that offer suitable warranties, except where an opportunity to receive funding support to trial a more exotic alternative may arise. Batteries should be included in the investment case for solar PV installations around the city due to the increased renewables consumption, potentially better economic returns and greater flexibility on using and supplying power locally.

There has been speculation about the potential to install a large battery connected to the Knutsford sub-station. This was discussed with Western Power who said the project would not be progressing through their channels. Western Power apparently consider that the network constraints are better addressed by traditional means and that batteries would not be a commercially sound investment decision.

If netting-off is permitted by Synergy, then energy storage may become less viable as the ability to share excess PV generation with other City sites would be more cost effective. See section 10.3 for detail.

4 Introduction to the Plan

4.1 Goals and objectives

The aims of the Plan, as per the original brief, are to:

- Reduce operational energy costs and help mitigate against the rising cost of conventional energy sources.
- Reduce carbon emissions and demonstrate the City's commitment to action on climate change.
- Improve the energy efficiency of City buildings and everyday corporate activities through the adoption of low-carbon technologies and energy efficient measures.
- Outline a cost-effective strategy to maintain the City's carbon neutral status while gradually reducing reliance on carbon offsets.
- Outline a plan to reach 100% renewable energy by 2025, that includes intermediate targets to assist in monitoring progress. The plan may include the purchase of certified green power, ideally from a local or Western Australian source.

4.2 How this report addresses the brief

This report contains the Plan, and correlates to the brief as per the table below.

Table 3: Meeting the Brief

RFQ Scope of Works Item	Relevant Report Section
Review the information package from the City of Fremantle and energy assessment.	Section 5, Page 27
Assess the feasibility of installing further renewable energy systems on City buildings or council land under the City's operational control, with consideration of the heritage status of some buildings.	Section 10.8, Page 85.
Liaise with the City's ESD consultant for the King's Square Development to ensure consistency of recommendations for the new Fremantle administration Building to be a zero-carbon development.	Section 6, Page 38.
Undertake an options analysis of potential mechanisms to achieve targets, including assessment against economic, social, environmental and governance considerations. The weighting of each consideration will be clearly identified.	Section 2, Page 6.
Detail of the preferred management actions identified from the options analysis.	Section 10, Page 45.
Outline the priorities for implementation with consideration to the yearly budget constraints for the City.	Section 2, Page 6.
Estimation costs and payback periods.	Section 10, Page 45

RFQ Scope of Works Item	Relevant Report Section
Outline options for reducing carbon credit offset costs.	Section 7, Page 39.
Compliance with the City of Fremantle’s sustainability strategy and the formal and/or informal application of One Planet Living principles.	Section 3.1, Page 15.

5 Review of available information

As part of this report the following reviews and interviews have been completed:

1. Reviewed
 - a. The financial information from the City of Fremantle for the past 5 years.
 - b. Greensense information
 - c. City provided information on gas, energy and water consumption
 - d. Information from Western Power and Synergy
 - e. Local Government energy saving programs around Australia
 - f. Streetlight replacement programs in other jurisdictions in Australia
 - g. Waste water treatment pilot projects
 - h. Solar and battery projects
 - i. City of Fremantle - Strategic Community Plan 2015-2025
 - j. City of Fremantle - Corporate Business Plan 2014-2018
2. Interviewed
 - a. City of Fremantle staff in the sustainability, facilities, finance & accounting, infrastructure departments
 - b. Fremantle Port Authority
 - c. Western Power
 - d. Synergy
 - e. Alinta
 - f. Energetics
 - g. Clean Energy Finance Corporation
 - h. Unity Water – Queensland
 - i. City Deals Committee
 - j. Curtin University Sustainable Policy Department
 - k. WA Local Government Association
 - l. Department of Transport
 - m. Greenbank UK
 - n. Local banks
 - o. Martin Bioenergy
 - p. Phoenix energy
 - q. Solar and battery producers/ installers, including Fremantle firms Solarluna and Infinite Energy.

5.1 Quality of Available Information and Data

Overall, we have had great difficulty in reconciling the information from the financial systems, departments and a variety of standalone excel spreadsheets forms. Overall, the various systems indicate issues with recording and reporting information within different functions. We were informed that asset management, repairs and maintenance programs are limited by available funds and long-term cost benefit analysis over the life of assets is not currently available. There appeared to be many people involved in manual reconciliations such as manually recording energy consumption and costs in Excel for review. This process could be automated.

Greensense has been engaged to provide consistent access to data. Our observation is that this information is not currently in use by City officers and, is not clearly correlated with information from other sources. One of the Management Actions recommended in the Plan is around data reform and the benefit to the City of a more robust approach to managing available energy information.

All staff we spoke to indicated a desire for improved data-driven insights to run a citizen-centric government that improves people's lives and improves the sustainability of the city.

5.2 Summary of estimated energy, cost and emissions profiles

The following chart shows the City's 2017 electricity and gas consumption profile, indicating the proportion of total load for the major elements: building electricity and gas consumption, and electricity consumption in street lighting, parks lighting, and carpark lighting.

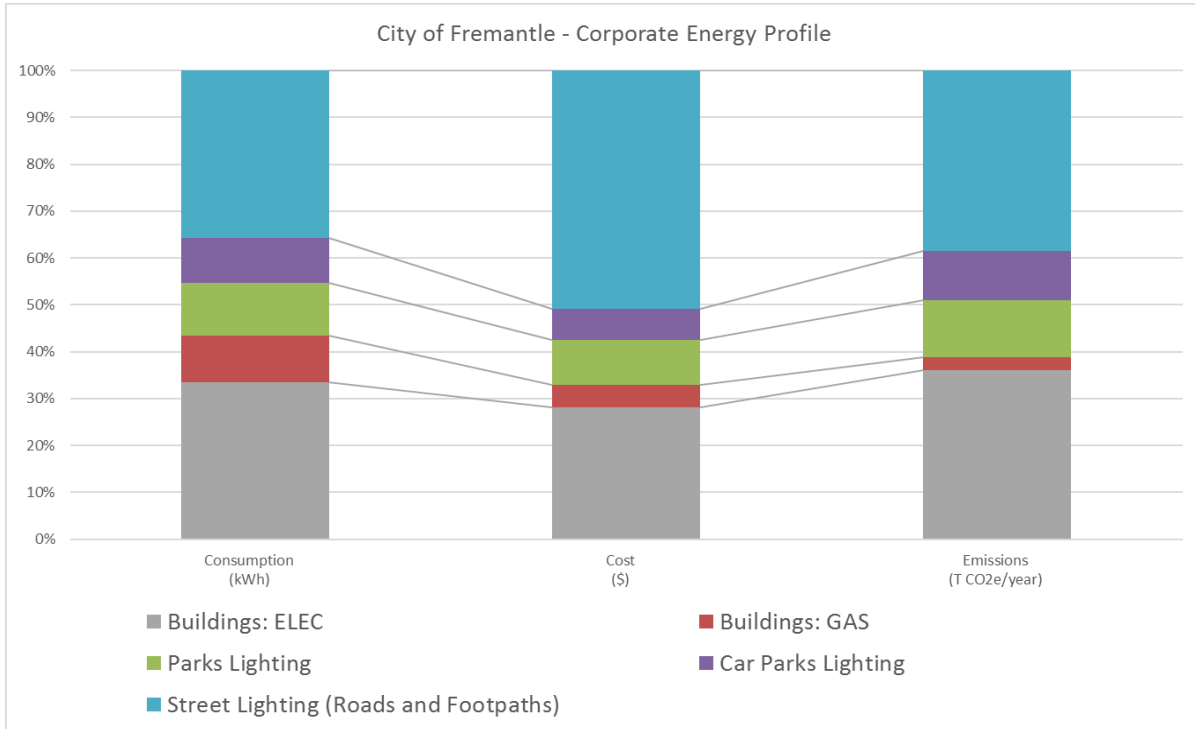


Figure 4: City of Fremantle Energy mix: Consumption/Cost/Emissions¹³

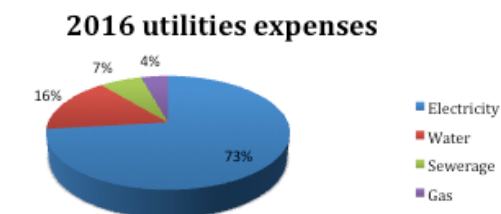
¹³ Based on provided City of Fremantle information -

5.3 Financial information - energy

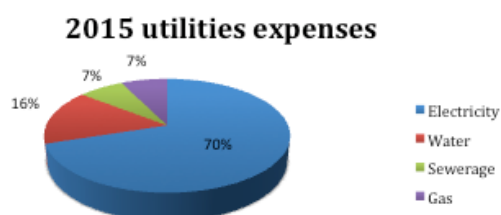
The below information was sourced from the financial statements of the 2015/2016 City of Fremantle Annual report. This is a breakdown of the total utility costs and a comparison to previous years.

Table 4: Financial Summary FYE2015 & FYE2016 (source: City of Fremantle)

Utility expense 2016	A\$	%
Electricity	1,645,195	73%
Water	357,813	16%
Sewerage	149,822	7%
Gas	96,081	4%
2016 Financial Statements	2,248,912	100%



Utility expense 2015	A\$	%
Electricity	1,680,774	70%
Water	379,846	16%
Sewerage	169,608	7%
Gas	174,556	7%
2015 Financial Statements	2,404,783	100%



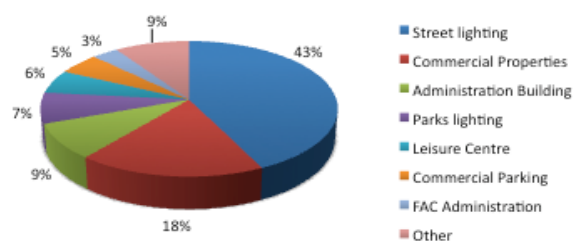
The City used 4,100,333 kWh in 2016 (2015: 4,461,429 kWh). As can be seen the costs for each category have decreased from 2015 to 2016 and represents greater efficiency gains captured by management. Considering that Synergy's electricity charges increased in the period means the actual energy efficiency gains were greater than the ultimate financial benefits. One area that has increased but is outside the control of management is street lighting costs. This is discussed in detail later in this document although is an area outside management's control where costs are increasing significantly year upon year. Electricity costs are broken down further below.

5.3.1 Electricity

All energy costs are billed by Synergy. Electricity costs are broken down further below.

Table 5: Electricity Cost Breakdown FYE2016 (source: City of Fremantle)

Category	A\$	%
Street lighting	704,764	43%
Commercial Properties	295,677	18%
Administration Building	140,172	9%
Parks lighting	120,785	7%
Leisure Centre	92,751	6%
Commercial Parking	85,078	5%
FAC Administration	53,816	3%
Other	152,153	9%
Electricity breakdown	1,645,196	100%



5.3.2 Trend analysis of main components of electricity consumption

The trend analysis for electricity costs indicates that overall the City's electricity costs have been decreasing

over time, except for street lighting. The cost of street lighting has increased: a symptom of increasing charges from Synergy that the City has no control over. Based upon the WALGA analysis of street lighting, Synergy's costs are high compared to other states. 'Building freehold, infrastructure and investments' are different classifications of 'Facilities' within the City of Fremantle accounting system.

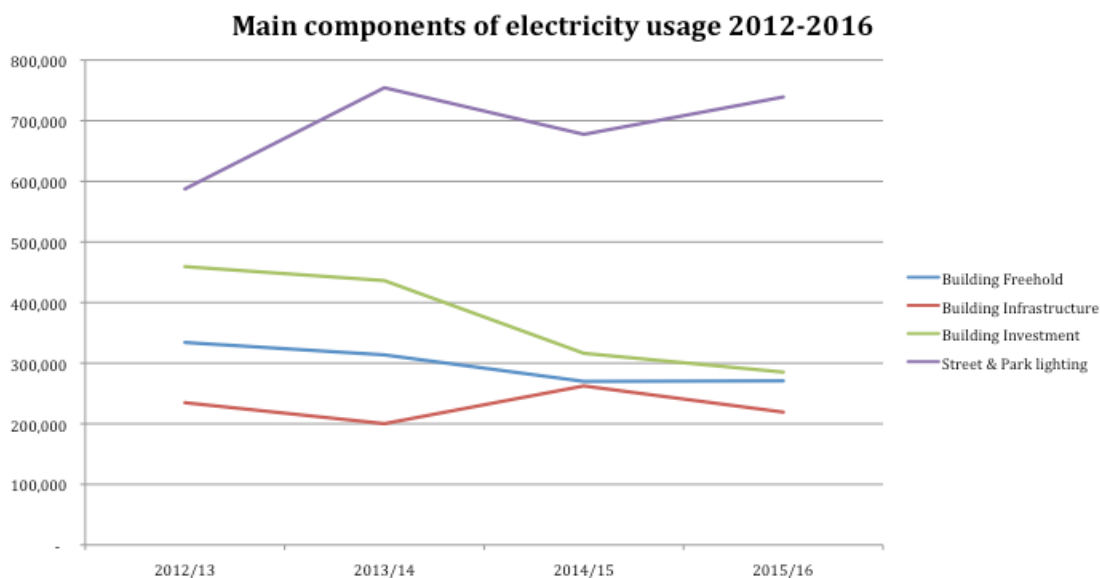


Figure 5: Cost trends for City electricity consumption - buildings and streetlights (\$) (Source: City of Fremantle)

The following sections are summaries of financial information that has been made available.

5.3.3 Electricity - Street lighting

Street lighting amounting to \$704,764 in 2016 is the highest energy cost to the City of Fremantle. This is discussed in detail later in this report.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	No
Management action point	Yes

5.3.4 Electricity - Commercial properties

Commercial properties are owned by the City of Fremantle then leased to third party tenants, who used \$295,677 of electricity energy in 2016. The energy costs are incurred by the City of Fremantle then recharged to the commercial property owners. We have not verified this recharging process as it is outside our scope of work.

As part of the energy efficiency reviews which the City will complete on its own building, this process could be extended, for a fee, to commercial lessees. Commercial owners may be willing to pay for this service as it should result in a decrease in energy costs. This also generates a positive new service that the City can provide to business owners while reducing energy costs in the City.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	Yes
Management action point	Yes

5.3.5 Electricity - Administration building

The existing administration building used \$140,172 of electrical power in 2016. The new administration building will be completed as part of the King's Square development. This is expected to be at least a 5-star NABERS rating that should result in reduced energy costs for the administration building in the future.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	No
Management action point	No

5.3.6 Electricity - Parks lighting

In 2016 parks lighting cost \$120,785 and is similar to street lighting that is separately discussed in section 7.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	No
Management action point	Yes

5.3.7 Electricity - Leisure centre

The leisure centre used \$92,751 of power in 2016. As with the other City of Fremantle buildings the leisure centre will receive an energy efficiency review that should result in reduced consumption.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	No
Management action point	Yes

5.3.8 Electricity - Commercial parking

Commercial parking are similar to commercial properties and cost \$85,078 in 2016. These parking facilities are owned by the City of Fremantle and leased to third party tenants. The energy costs are incurred by the

City of Fremantle then recharged to the commercial parking operators. We have not verified this recharging process as it is outside our scope of work.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	Yes
Management action point	Yes

5.3.9 Electricity – Fremantle Arts Centre - Administration

The Fremantle Art Centre electricity costs cost \$53,816 in 2016. These costs will likely decrease with an energy efficiency review.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	Yes
Management action point	Yes

5.3.10 Electricity - Other

Includes civic and public halls, Community safety and rangers, The Meeting Place, The Moores Building art gallery, Samson Recreation Centre, Library and Civil works operations and amounted to \$152,153 of costs in 2016. The City of Fremantle building will undergo energy efficiency reviews.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	Yes
Management action point	Yes

5.3.11 Gas

Gas cost in FYE2016 was \$96,081 and relates to the hot water heating in the administration building, the Fremantle Leisure Centre and the Meeting Place. Gas consumption is expected to decrease due to the replacement of the administration building. Additional reduction in gas can occur by replacement with solar heating. This is a discrete project discussed in section 7.

The Fremantle Leisure Centre has gas co-generation as well as an unused, disconnected solar panel installation.

Opportunity to reduce costs	Yes
Opportunity to increase revenues	No
Opportunity for new services	No
Management action point	Yes

5.3.12 Water and Sewage

Consideration of embodied energy in water and sewage services is outside the scope of this report, however some information is provided below for completeness.

- Water costs of \$357,813 relate to water charges from Water Corp.
- Sewerage cost \$149,822 in 2016 was paid to Water Corp to dispose of sewage.

There is significant energy embodied in the metropolitan mains water system. Total energy content per kilolitre (kL) of water consumed is 2.98 kilowatt-hours (kWh). According to Water Corp’s 2016 Annual Report, energy intensity was:

- Mains water supplied: 2.17 kWh/kL
- Wastewater processed: 0.81 kWh/kL

For the City of Fremantle this amounts to 247,100 kWh based on the provided figure of 84,917 kL consumption for 2015/16, or approximately 6% of the total electricity consumption for the year.

This energy is not currently assessed in City carbon calculations, but should be included in a complete assessment.

There are other benefits to reducing water consumption, in addition to the energy and emissions reductions. Potential savings through water initiatives are indicated in the table below. These are savings based on case studies of similar projects completed in Australia and the UK. These figures are presented advisedly, acknowledging that varying amounts of work and capital outlay are required to achieve these savings.

Table 6: Potential Cost Savings - Water

Item	Short/medium or long term	Estimated Certainty	Potential cost savings per year (2016 figures)	Nett present value over 10 years ¹⁴
Water efficiencies ¹⁵	Short term	60%	7,258 ¹⁶	62,098

5.4 Street and Park lighting

Street lighting is a key public service provided by the City of Fremantle and is essential for personal safety, crime prevention, urban ambiance and road safety. Wisely used street lighting can also positively boost the appeal of urban environments while highlighting attractive local landmarks or accentuating the atmosphere during important public events.

The current street and park lights installed throughout the City of Fremantle are a mixture of Metal Halide, High Pressure Sodium, Mercury Vapour and Compact Florescent. These traditional streetlight bulbs are not as energy efficient as modern Light Emitting Diodes (LED) and need to be replaced more often. Traditional street lights also cause unnecessary unfocused light pollution or photo pollution and heat pollution. This means the costs of street lighting for the City of Fremantle is higher than it needs to be. This issue is well known to the City of Fremantle staff and management however, Western Power and Synergy have only recently provided

¹⁴ Potential discounted cost savings at 5% & free cash flow inflation of 2%

¹⁵ Discounted over 10 years

¹⁶ Total cost of parks water used in 2016 – \$36,288. Comparable projects 20% cost savings. Therefore, the total cost benefit = \$7,257

approved LED replacements for one type of bulb. It is expected that LED replacements for all bulb types will be available towards the end of 2017.

Street lighting and park lighting around the City in 2016 cost \$825,549 or 50% of total electrical costs in the financial statements. It is the largest single utility cost the City of Fremantle incurs but the City has little control over costs, operations or maintenance. The total cost of a typical street lighting installation over a period of 25 years is split approximately as 85% maintenance/operation (including power supply) and 15% capital cost¹⁷.

The following table shows the deemed breakdown of energy and costs. This table has been compiled for this report based on research into the make-up of the Synergy charges for street lighting, which are typically a lump sum with little breakdown.

¹⁷ Energy Efficient Lighting Systems – European PPP Expertise centre 2014

Table 7: Summary of City of Fremantle Street lighting - lamp technologies, sizes and associated tariffs

Street lights summary	LED	CFL	HPS	HPS	HPS	MV	MV	MV	MV	MH	MH	MH	Unmetered	Total
Watts	22	100	70	150	250	80	125	250	400	70	150	250	-	
Lumens per Watt (Synergy)	150 ¹⁸	60	100	100	100	55	55	55	55	80	80	80		
Hours/ night	10	10	10	10	10	10	10	10	10	10	10	10	10	
Electricity cost cents per day ¹⁹	32	38	56	56	85	44	55	74	110	81	111	139	Flat fee	
Useful life hours (Synergy)	50,000 ²⁰	14,000	14,000	14,000	14,000	12,000	12,000	12,000	12,000	8,000	8,000	8,000		
Life span years	20+	5	5	5	5	4	4	4	4	5	5	5	5	
Cost per replacement	\$1,785	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	\$1,400	
Est operating cost per year 2017 \$	\$116	\$137	\$206	\$206	\$309	\$159	\$201	\$269	\$402	\$294	\$407	\$507	N/A	
Total lights		486	3	120	981	883	348	65	2	264	8	10	239	3,409
Estimated yearly cost \$		\$66,710	\$617	\$24,661	\$302,946	\$140,284	\$69,871	\$17,482	\$804	\$77,675	\$3,252	\$5,071		\$709,372

The above summary shows the number of bulbs by type and the tariffs charged by Synergy. The oldest street lighting technology is 'MV' (mercury vapour) that makes up 41% of the City's portfolio.

Western Power owns the majority of the City of Fremantle's and Western Australia's street lighting infrastructure and has little incentive to introduce more energy efficient technologies given that it may not recognise the economic or community benefits in the current monopoly environment. All Western Power charges are on a cost-plus basis to Synergy who then provides the retail tariff to the City of Fremantle. This approach provides a perverse incentive to increase rather than reduce costs and with little to no accountability or transparency. It may be that the incumbent utilities could be worse off financially as a result of the lower electricity consumption, maintenance costs and extended operating life associated with the more efficient technology. It appears that street lighting charges are subsidising other parts of the Synergy business. This was affirmed by Synergy representatives in a workshop on 27th July.

¹⁸ CREE. Warrnambool street lighting project

¹⁹ Z - C tariff - (dawn switch off) - Synergy tariffs from September 2016

²⁰ Ergon energy

A review of lighting upgrade programs was undertaken to understand the processes and lessons learned, as well as to develop an estimate of cost savings. Cost savings estimated for the Fremantle street light replacement program are estimated at 50%, which is conservative compared to the projects below.

Table 8: Review of street lighting upgrade case studies

City	Project scale	Energy and maintenance savings
Lehrte (Germany)	Replacement of 4,500 street lights	54%
Warrnambool - Victoria	Replacement of 2,000 street lights	68%
Knox City council - Victoria	Replacement of 10,000 street lights	78%
Pilbara Street Light Replacement program - WA	Replacement of 674 street lights	50%
City of Sydney - NSW	Replacement of 22,000 street lights	50%

5.5 Summary of Information Review

Table 9: Summary of information provided on energy use in key sectors and assets (source: City of Fremantle)

Electricity FYE2016	Street lighting	Commercial properties	Administration building	Parks lighting	Leisure centre	Commercial parking	Fremantle Arts Centre	Other	Total
Total electricity cost FYE2016	\$704,764	\$295,677	\$140,172	\$120,785	\$92,751	\$85,078	\$53,816	\$152,153	\$1,645,196
Total Electricity consumption (kWh) FYE2016	6,586	N/A	689,154	535,066	494,407	456,599	231,857	176,208	2,589,876
Total Electricity production (kWh) FYE2016	N/A	N/A	N/A	N/A	Not connected	N/A	N/A	16,584	16,584
Total gas cost FYE2016	N/A	N/A	\$3,443	N/A	\$57,252	N/A	N/A	\$157	\$60,852
Total gas consumption (MJ) FYE2016	N/A	N/A	137	N/A	581	N/A	N/A	384	1,102
Opportunity to reduce costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Opportunity to increase revenues	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Opportunity for new services	No	Yes	No	No	No	Yes	No	No	No
Management action point	Yes	Yes	No	Yes	Yes	Yes	No	No	No

6 King's square development

Information in this section was provided by City's ESD consultant for the King's Square Development, Link Engineering, in a brief on the design intent for the new Fremantle Administration Building, and the City's objective for it to be a Zero Energy Building.

Additional items, not yet considered by the building engineers include:

- Voltage Optimisation (VO): The current City admin building had a voltage optimisation unit that ran for several years. Building engineers for the new admin building should consider VO and invite a supplier to propose a system, with an accompanying business case.
- Numen: this device, developed by local Fremantle firm Ecocentric Energy, is at the leading edge of energy monitoring and management. It contains an analysis algorithm licenced from CSIRO that allows it to detect devices remotely based on their unique 'energy signature', and to log their usage, energy consumption, approaching failure and other metrics.

6.1 Briefing notes from building engineers

Overall, according to Sven De Jonghe the development is progressing smoothly and is on track to achieve a minimum 5-star NABERS rating.

- Kerry Hill architects are doing the façade. Energy and environmental modelling to occur later this year when more details are available. The library is now partially underground which reduces future cooling costs. The labyrinth underground cooling system has been eliminated due to cost concerns.
- The building will use mixed ventilation, relying on air-conditioning during the hottest and coldest parts of the year. 65% of the year, air-conditioning will not be required, and only on peak days will air conditioning be used. Sunscreens will have a dual purpose to also dampen high winds.
- Solar PV is expected to be approximately 150-200Kw that is approximately 25% of the building's power requirement. There are places to install batteries but it is expected the price of batteries will come down and may likely be installed in a couple of years. The other 75% of the building's power requirement will be sourced from green power generation. There will be separate metering of retail, commercial and council buildings to ensure the City of Fremantle only pays for its power consumption.
- The schematic design is finalised. Detailed design is currently underway and should be completed towards the end of 2017. There will be a dynamic environmental and sustainable modelling process later this year after the details of the final building are clear. The building is targeting five-star NABERS minimum for energy efficiency.
- Practical completion date is to be finalised.
- There is a water-cooled chilled water system. Cooling towers are on the roof. Normal refrigeration will be used for the water-cooling. Double-glazing is expected but will be confirmed in the final architect design. There will be some tinting of the glass. The key is the louvers and the blades are still be selected.
- The control of the air conditioning system is to be decided although it will be automatic with manual

override to avoid people switching it on every day. The windows will be automated to open in conjunction with the air-conditioning status.

- The structural system is still to be decided although long spans are likely. Gas boilers will be used for heating where required.
- The most efficient water minimisation technology will be used. No grey or rainwater harvesting.
- The development is aiming to follow the Green star code without achieving certification due to the uneconomic cost circa \$500,000. It is understood the Council approved not using Green star certification.
- Insulation is in compliance with existing guidelines 100mm in the walls, 125mm in the roof and 'R1.0' (typically 50mm rigid board) insulation in the car park ceiling, building floor.
- Sub metering will be on each floor to measure and monitor consumption. Smart metering with remote monitoring system still to be decided.

7 Outline options for reducing carbon credit offset costs.

The City of Fremantle currently purchases approximately 6,000 metric tonnes of carbon offset from the market. The primary proposition of this Plan for reducing these costs is to move all electricity to 100% renewable energy that no longer requires offsetting.

By following this Plan, the City of Fremantle will be significantly reducing the requirement for incurring carbon offsets. If all the recommendations are fully implemented there is still expected to be a portion of carbon emissions that will need to be offset, in particular gas consumption and transport fuels.

The City is offsetting emissions voluntarily, so does not necessarily need to meet any particular definitions of 'carbon neutral', however a standard definition does exist in Australia: The National Carbon Offset Standard (NCOS)²¹. The City would need to meet various requirements to be compliant with the standard, including:

- 1) Credible greenhouse gas measurement techniques, which ensure the emissions and emissions sources covered by a claim of carbon neutrality can be readily understood and evaluated by others.
- 2) Independent auditing every second year, to ensure emissions have been accurately measured, offset and reported.
- 3) A reasonable attempt has been made to reduce in-house emissions before using offset credits.
- 4) Genuine offsets units have been purchased and cancelled to compensate for all emissions associated with the claim.

Once again, although the City is not bound to complete compliance with the standard, it should be used as the key guideline in this area, with any non-compliances being made knowingly after consideration. One of the services provided in the standard is a list of offset types that have been reviewed against a set of published criteria. These are published as an appendix to the standard: Eligible Offset Units²².

²¹ <http://www.environment.gov.au/climate-change/carbon-neutral/ncos>

²² <http://www.environment.gov.au/system/files/resources/749d844e-4ee8-440b-bf1d-19365046b2bc/files/national-carbon-offset-standard-v3-appendix.pdf>

Any offset units commercially purchased should be of a type listed in the latest version of the appendix, and the supplier should be asked to confirm this.

It is not unusual to claim exports of renewable energy as a carbon credit for the exporter. For example, the City may have a site that is exporting electricity to the grid from a PV system that is exceeding the building load. That exported electricity could be considered an offset to other City carbon emissions, based on the carbon intensity of grid electricity published in the NGERs Factors²³. However, if the City receives a feed-in tariff, then the exported electricity has been purchased by the retailer, and, depending on the regulations that apply, could be sold on as green energy. If the City were to claim the offset, there would be an effective double counting, therefore this is not acceptable for offsetting.

²³<http://www.environment.gov.au/system/files/resources/5a169bfb-f417-4b00-9b70-6ba328ea8671/files/national-greenhouse-accounts-factors-july-2017.pdf>

8 Innovative financing partnerships

The City of Fremantle may be interested in exploring innovative financing partnerships to improve outcomes for the city, the environment and local heritage. Innovative financing provides opportunities to improve value for money, encourage new and novel solutions to problems and reinforces shared stewardship with business and the community.

Mechanisms such as green bonds, impact investment, private equity and corporate partnerships have been used to deliver conservation outcomes in Australia and internationally. For example, the Clean Energy Finance Corporation is providing up to \$100 million in finance to Origin Energy to assist in its rollout of rooftop solar photovoltaics for Australian households and business. Origin Energy's 'Solar as a Service' uses power purchase agreements to eliminate the need for customers to cover upfront solar photovoltaic system costs. This finance supports Origin Energy in providing power purchase agreements to these customers, allowing them to buy their own solar-generated energy for an agreed period and at an agreed price, which encourages the deployment of solar and battery storage solutions. This model could be used in Fremantle as well to reduce carbon emissions within the city.

The City of Fremantle could also explore financing mechanisms to facilitate private investment in projects that will improve developments around the city, Victoria Quay in particular, building upon the success of King's Square development.

8.1 Clean Energy Finance Corporation

The Clean Energy Finance Corporation (CEFC) was created by the Australian Government and operates under the Clean Energy Finance Corporation Act 2012.

The CEFC offers local government specialised finance for a variety of projects including;

- Energy from waste projects - to create an energy source from council waste, reducing both landfill and energy costs
- Rooftop solar PV on council buildings - to provide a renewable energy source using the council's own assets
- Street lighting upgrades - to convert to more efficient LED lighting, which can cut energy costs as well as operation and maintenance costs
- Building upgrades - to improve energy efficiency through a broad range of options, reducing energy costs
- Leisure and aquatic centres - to systematically address these high energy users, with a combined approach to introduce better heating, ventilation and air conditioning solutions as well as renewable energy sources
- Electric and low emissions vehicles - to lower council fuel bills at the same time as lowering emissions; can include related infrastructure such as charging stations
- Other projects can also be considered where they fall within the CEFC's mandate, which covers renewable energy, energy efficiency and low emissions technologies.

There are numerous firms offering financing for energy projects from solar PV installations to microgrid developments and renewable energy projects. The offerings are constantly changing and to secure external

financing suitable Business Cases need to be prepared. Based on these Business Cases a procurement and financing process can be undertaken to identify the most appropriate solution based on current conditions.

For further information: <http://www.cefc.com.au/>

8.2 ARENA

The Australian Renewable Energy Agency (ARENA) has recently launched a new plan titled *Innovating Energy*. The agency has set a target of 30% of the country's electricity to be generated from photovoltaics within 20 years. Innovating Energy has set out four new priorities, where ARENA will commit almost \$800 million (AUD) in funding:

- Delivering a secure and reliable electricity system
- Accelerating solar PV innovation
- Improving energy productivity
- Exporting renewable energy

For further information: <https://arena.gov.au/funding/>

8.3 City Deals

The Smart Cities Plan, a program of The Department of Prime Minister and Cabinet, will support the kinds of projects discussed in this Plan. The approach is more strategic than simple funding, requiring Cities to enter into a collaborative process with Government, the private sector, and the community. So far, Launceston and Townsville have City Deals, with Western Sydney under development. The Corporate Energy Plan could be a useful first step in establishing a City Deal for Fremantle.

<https://cities.dpmc.gov.au/city-deals>

9 Methodology and decision-making process

This section outlines the process followed to develop the Plan, and explains the format that has been used to present the proposed Management Actions that form the Plan.

9.1 Method Statement

This statement intends to succinctly outline the philosophy that is guiding the review of potential options for the City around energy.

Reduce energy use where changes are cost effective and amenity is maintained, then find alternative sustainable energy sources with improved economics compared to current arrangements. Where carbon emissions cannot be avoided, they are offset annually.

9.2 Review Process

A large number of Management Actions (changes and interventions that can be made by the City to progress the Plan) have been reviewed in the course of developing this proposed Plan, and those that are considered viable have been included. The proposed Plan is the result of an agreed review process:

- 1) Two drafts of the Plan were provided to the City in the development of this Plan, with any comments addressed in the subsequent draft.
- 2) The early stage status of the Plan was presented to elected members at an informal briefing.
- 3) Particular officers at the City have been asked to review relevant sections of the Plan in a final stage review process prior to submitting the proposed Plan.
- 4) The proposed Plan has been reviewed by the City's Senior Project Officer - Sustainability, who is managing the project.
- 5) A final proposed Plan was developed from the last review comments, and this version was put to Council for adoption.

9.3 Template for Presentation of Management Action options

The detail of proposed Management Actions is contained in the Options Analysis (section 10 of this report). A consistent layout has been adopted for each Action to aid review and decision making.

The following section contains the detailed information on the Management Actions that together form the Plan. Each Management Action has its own section based on a template with the following parts:

- Short title and subtitle - for consistent reference.
- A summary of recommendations - the actions that would be taken by the City.
- Background - on why the Management Action is being proposed.
- Detail – the expected impact of the Management Action.
- Interaction with other Actions – identifying where there is crossover or interdependence between actions.

- Triple Bottom Line and One Planet Living (OPL) Analysis - the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts:
 - Financial Analysis: using a suitable tool such as NPV or Levelized Cost of Energy (LCoE) to assess the value of a proposal over an appropriate period, for example: the 25 years of a typical PV module warranty.
 - Environmental Analysis: Replacement of fossil fuelled energy with renewable energy, City corporate CO₂ emissions impact. Waste impacts.
 - Social Analysis: Leadership value of the Action, or other social impacts.
 - OPL Analysis: A review of the Action against the 10 Principles of OPL, noting any impacts.
- Risk review – identifying potential risks and responses around the proposed Action.
- Program for Implementation – identifying the Action as Stage 1, 2, or 3, and identifying any hold points or gateways to assist project management.
- Benchmarks – any salient performance figures that the eventual implementation should be measured against. These benchmarks are intended to inform an Energy Plan Status Update (described as a Management Action) that will report on progress of implementing the Plan.
- Summary – a tabular summary of the Management Action.

10 Recommended Management Actions

The proposed Management Actions that comprise the Plan are listed here and detailed in the following sections.

Table 10: List of Proposed Management Actions

Title	Description
Governance	
Energy Data Reform and Annual Energy Report	Data reform - propose a reporting regime (separate to the Plan) that harmonises with City financial reporting to enable robust, regular review.
Energy Plan Status Update	An annual report, submitted to Council, on the progress of the energy plan. An appendix to the Annual Energy Plan, if adopted.
Energy Portfolio	Proposal for a portfolio approach to the City's accounts to simplify accounting and potentially unlock other benefits.
Fremantle Leisure Centre – Energy Systems	Problems with the connection of the PV system and with the operation of the cogeneration system examined.
Demand side	
Energy Efficient Buildings	Energy Efficient Buildings policy/strategy - process and benchmarks for continuous improvement (note items in the proposal under "Site Level").
Street Lighting Upgrades	Street lighting strategy - based on Western Power / City agreements
Voltage Optimisation	Voltage Optimisation - triggers a review of VO at >300MWh/year, supplier led review and guaranteed performance contract.
Supply side	
City Owned Photovoltaic Systems	PV installs on City owned buildings.
Local Renewable Energy Supply	Other local renewables projects - how to incentivise.
Gas Accounts	Rationalising CoF accounts.
Transport	
Low Emissions Fleet	Low emissions fleet - benchmarks over the life of the strategy driving lower emissions

10.1 Management Action: Energy Data Reform and Annual Energy Report

10.1.1 Sub Title of Management Action

Reform of Data Capture and introduction of an Annual Energy Report

10.1.2 Summary of Recommendations

Create an Annual Energy Report that is a standard element of the City's annual reporting, and that requires that energy data be reconciled with financial data annually.

10.1.3 Status of Management Action

This Management Action is internal and should begin as soon as resources are available.

The recommendations and content of this Management Action have been reviewed by Paul Skipworth, Senior Finance Officer – Budgeting, City of Fremantle.

10.1.4 Description

1. Data reform – review existing reporting arrangements and develop a specification for energy data gathering and presentation for every City asset.
2. Annual Energy Report - propose a reporting regime that harmonises with the City processes. The report must enable robust, regular review, submitted to Council for approval, and aligned to existing reporting regimes, particularly City financial reporting.
3. Look for opportunities to add a game layer to energy performance; Once there is consistent reporting for facilities, managers or other champions that have influence at those facilities can be incentivised to improve energy performance.

10.1.5 Detail

(a) Data Reform

The City's energy consumption data is provided by the current retailer, Synergy, in energy bills. Some sites also have time interval data available. This data, along with production information from PV systems, and the cogeneration system at the Fremantle Leisure Centre, is being compiled by Greensense, and made available through their reporting and dash-boarding system. During the review of available data for the development of this Plan, a number of observations were made:

- Greensense data is not being regularly accessed by City staff, although some recently engaged staff may find it useful.
- Recommendation: A City account manager should be identified for Greensense, for example the proposed Energy Officer, who can manage the optimal use of Greensense and assess value for money. Interested staff should be identified and properly inducted by Greensense. Greensense

should explain the kinds of reporting available and agree with staff on implementing their reporting needs.

- The naming convention used in Greensense is not aligned to City consumption.
- Recommendation: Create a cross reference aligning the account numbers used in Greensense with the City assets that the accounts apply to. Request a quote from Greensense to update the naming convention in their system. If this cost is high, request that the document that aligns the naming convention to City consumption be uploaded and made available on the City homepage on the Greensense portal.
- The data that was retrieved from Greensense could not be reconciled with data provided by the City from other sources.
- Recommendation: review how energy data, and energy cost data, is compiled by the City Finance Department. Establish a simple cross check so consumption that is being paid for aligns with data that is being recorded in Greensense. This cross check would form part of the Annual Energy Report, as recommended below, if adopted.
- Other providers exist who could potentially provide the required service at a lower cost, and may include the required reporting as part of the service, if it can be clearly specified at engagement.
- Recommendation: Review the cost of the Greensense service, including costs that would come from implementing the above recommendations. Create a basic specification for the required services and take to alternative suppliers for proposals.

(b) Annual Energy Report Structure

The report would cover three main categories of energy at the City: Fixed assets, public realm lighting, and transport. The report would also address water consumption for the fixed assets (because of the energy profile of water supply, and because the information should be captured), and focus on emissions in the transport section. It could also be referred to as the Annual Utility Report, to give flexibility on the content.

The structure of the proposed Report is as follows:

Whole of City Corporate

- Exec summary: Any notable changes to the City's energy footprint.
- High level: Presentation of the overall energy profile of the City, with comparison to previous years (once a robust data gathering process is in place). Includes visualisation of the energy profile (the mix of sources and sinks).

Fixed assets

- By asset number: all assets presented with figures (with comparison to previous years once a robust data gathering process is in place) for:
 - Electricity Consumption (kWh)
 - Annual Electricity cost (\$)

- Production of Electricity (if generation is present) (kWh)
- Annual value of production of Electricity (\$)
- Gas Consumption (kWh)
- Annual Gas cost (\$)
- Water Consumption (kWh)
- Annual water cost (\$)
- Comparison to benchmarks for that asset type (once developed within the City or in collaboration with WALGA or others)
- The twenty highest energy consuming assets are highlighted.

Public Realm Lighting

- Present a table as per the following, updated each year for the lighting mix, applicable tariffs etc.

Street lights summary	LED	CFL	Other lamp types..	Total
Watts	22	100	Rated wattage	
Lumens per Watt (Synergy)	150	60	Rated lm/W	
Hours/ night	10	10	Standard night / programmed / sensor	
Electricity cost cents per day	32	38	Applicable tariff / daily cost	
Useful life hours (Synergy)	50,000	14,000	Rated life hours	
Life span years	20+	5	Shelf life	
Cost per upgrade from an existing, older lamp	\$1,785	\$1,400	Upgrade cost	
Est operating cost per year 2017 \$	\$116	\$137	Annual cost	
Total lights	0	486	Number of this type installed	xxx
Estimated yearly cost \$	0	\$66,710	Annualised cost	\$xxx.xxx

Transport emissions

- Fuel consumed:
 - Total km and total litres per fuel type
- Emissions:
 - Total km and total emissions for the year (converting fuel use to emissions using NGERs²⁴ factors),

²⁴ The latest NGERs Factors are for 2016: <http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-aug-2016>

- Average grams of CO2 per km
- Benchmark / target [e.g. 102 gCO2/km] (see Management Action: Sustainable Corporate Transport for detail)
- Per Vehicle:
 - Type and age of vehicle
 - Total km and total fuel consumption
 - Average L/100km.

Actions

- All of the above metrics are subject to Management Actions detailed in the Corporate Energy Plan, and so are expected to be impacted as the Plan is implemented. Additional actions may emerge in the compilation of the Report and should be included in this section with a clear, actionable recommendation.

Appendix:

- Energy Plan Status Update (see separate Management Action)

(c) Process Notes

The final form and timing of this report needs to be well integrated with City processes, with the intention that it be presented directly to Council along with financial reporting. To this end, the newly revised asset numbering system should be the fundamental unit of reporting for fixed assets, so that reporting of various kinds (including energy and financial reporting) can be collated in a straightforward way.

(d) Assumptions

4. That there is the opportunity to add a formal reporting element, as described, to the City's annual reporting processes.

10.1.6 Interaction with Other Actions

Distinguishing the *Annual Energy Report* from the *Energy Plan Status Update*: All aspects of the Corporate Energy Plan will have an impact on the metrics in the *Annual Energy Report*, however progress on the particular initiatives of the plan should be part of the *Energy Plan Status Update*. The *Energy Plan Status Update* would track the status of the Corporate Energy Plan over the period of the Plan, whereas the *Annual Energy Report* is proposed as a permanent addition to the City's annual reporting.

The *Annual Energy Report* could include the *Energy Plan Status Update* as an appendix.

10.1.7 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

The cost of this Action could be absorbed by the City, or minimum 8 hours of consulting time per year should be allowed to gather the required data and present in the agreed template.

(b) Environmental Analysis

The environmental impacts are those associated with energy management in general.

(c) Social Analysis

Transparency is a key element of healthy governance.

(d) OPL review

One Planet Living (OPL) is focused on continuing change and improvement. This Management Action will provide documentation directly applicable to ongoing OPL reporting.

10.1.8 Risk Review

Title	Description	Mitigation
Reporting poor outcomes	If a change in consumption, or another factor, has not been anticipated, the City may not technically be carbon neutral in a given year.	Carbon neutral standards can be met in a robust way that allows for some variation in year-to-year inputs. Allow a contingency of up to 5% on offsetting and report the carbon neutral status on a 3-year average.

10.1.9 Program for Implementation

This is a Stage 1 action. Recommend a temporary role of ‘energy officer’ to oversee the implementation of governance changes such as this one.

10.1.10 Benchmarks and other measures to be included in reporting

The benchmark for this Action is the completion of regular reports.

10.1.11 Summary of Management Action

Action	Annual Energy Report
Final Recommendation	Create an Energy Report that is a standard element of the City’s annual reporting, and requires that energy data be reconciled with financial data annually.
NPV / LCoE	na
Renewable Energy (kWh/year)	na
Emissions (+/- Tonne CO2e/year)	na
Leadership value	Transparency and governance
OPL impacts	OPL’s overall philosophy is around continues improvement, which requires monitoring and reporting.
Plan Stage to implement	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. •Data reform: The structure of the report will require a regular reconciliation of energy data to financial data.

10.2 Management Action: Energy Plan Status Update

10.2.1 Subtitle of Management Action

An annual report outlining the progress of implementation of the Corporate Energy Plan.

10.2.2 Summary of Recommendations

Annual reports (as appendix to the Annual Energy Report, if adopted) tracking the progress of the Plan.

10.2.3 Status of Management Action

This Management Action is internal and should begin as soon as resources are available.

The recommendations and content of this Management Action have been reviewed by Paul Skipworth, Senior Finance Officer – Budgeting, City of Fremantle.

10.2.4 Description

An annual report on the progress of the energy plan. A standard format for this report is proposed, which addresses agreed interim targets. The intention is that the status of the rollout of this Plan, regularly updated of by an assigned City Officer, be tabled with Council. If an *Annual Energy Report* (see separate Management Action detail) is instigated, as recommended elsewhere in this Plan, then the *Energy Plan Status Update* would be an appendix to this.

10.2.5 Detail

The structure of the proposed report is as follows:

- 1) Exec summary: Presenting progress against the previous year's report and any notable achievements or impediments during the year.
- 2) Staging: The Plan is conceived in stages, rather than fixed dates. Therefore, this section identifies the Current Stage in the context of a staging for the overall Plan.
- 3) Management Actions: Presentation of the full table of Management actions with the status of each, and progress toward completion of agreed Management Actions. Where appropriate, Management Actions will include interim targets in their description, so progress towards interim targets can be presented. Cost variations and cost-to-complete each Management Action should be included.
- 4) Conclusion: The Plan will include visualisation of the overall City energy footprint. This footprint should be updated in the reports to track progress visually.

(a) Process Notes

The detail of the report, lodgement with Council, and other details need to be captured in City processes and assigned to particular job description and officer.

The report would be annual to the end of 2025, with the final report to include recommendations for next steps in the Fremantle energy strategy.

(b) Assumptions

That there is the opportunity to add a formal reporting element, as described, to the City’s annual reporting processes.

10.2.6 Interaction with Other Actions

All Management Actions would feed into this report.

Note: the intention is that this report be specific to the Corporate Energy Plan and all adopted Management Actions that result from it, while the *Annual Energy Report* would be produced in its own right, and continue beyond the lifetime of this Plan.

This *Energy Plan Status Update* may sit as an appendix to the *Annual Energy Report* for the period of the Plan.

10.2.7 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the ‘value’ of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

The cost of this Action could be absorbed by the City, or minimum 8 hours of consulting time per year should be allowed to gather the required data and present in the agreed template.

(b) Environmental Analysis

The environmental impact of this action is tied to the impact of the Plan as a whole.

(c) Social Analysis

Transparency in governance of initiatives such as this Plan is good practice.

(d) OPL review

One Planet Living (OPL) is focused on continuing change and improvement. This Management Action will provide documentation directly applicable to ongoing OPL reporting.

10.2.8 Risk Review

Title	Description	Mitigation
Reporting lack of progress	Barriers such as budget or resourcing can interrupt the progress of a major strategy	The City may choose to suspend the plan for a period, rather than reporting no progress.

10.2.9 Program for Implementation

Annual for period of Plan.

10.2.10 Benchmarks and other measures to be included in reporting

The benchmark for this Action is the completion of annual reports.

10.2.11 Summary of Management Action

Action	Energy Plan Status Update
Final Recommendation	Create an Energy Plan Status Update report for the period of the Plan to 2025. Issue this as an appendix to the Annual Energy Report.
NPV / LCoE	na
Renewable Energy (kWh/year)	na
Emissions (+/- Tonne CO2e/year)	na
Leadership value	Transparency and governance
OPL impacts	OPL's overall philosophy is around continuous improvement, which requires monitoring and reporting.
Plan Stage to implement	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> • Annual Energy Reports: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. • All actions: All agreed Management Actions to be reported on.

10.3 Management Action: Energy Portfolio

10.3.1 Subtitle of Management Action

City of Fremantle Corporate Energy Service Portfolio.

10.3.2 Summary of Recommendations

1. Resolve with Synergy and Western Power whether the City Electricity accounts can be amalgamated and treated as a single, contestable portfolio.
2. Negotiate annual reporting with Synergy
3. Negotiate single tariff across Portfolio
4. Resolve with Synergy whether 'netting-off' between sites can be enabled, and whether Western power will discount the network charges to make this attractive.
5. Resolve with Western Power whether PV systems on City facilities can be approved en-masse.
6. Confirm with Synergy what the costs are, if any of distributing power between different sites behind the Knutsford meter. (Western Power have confirmed in writing they do not charge for this.)

10.3.3 Status of Management Action

This Management Action is multi-faceted; some elements will be more straightforward than others to implement. There have been numerous meetings and ongoing contact with utilities, particularly Western Power, the network operator in WA, and Synergy, the State-owned retailer that is also the City's retailer.

The most recent contact has been with Synergy, with a meeting at the City on 27/7/2017.

The City's account manager, Anazia Farla, followed up on 31/7/2017 with responses to some written questions that were posed, see Appendix 1. Most items required further internal investigation by Synergy. It was stated that the make-up of street light tariffs is not available.

A further informal meeting with Aidon Thomas from Synergy yielded the following responses:

- Q: Could Synergy provide some level of amalgamated reporting direct to the City? You probably have some standard reporting already but they would ask for an annual report showing monthly consumption and cost (energy and fixed separate) for each account. The Peak demand per site might be useful if available. The tariff being applied and any notes (e.g. being subject to a back-to-back contract for green energy supply).
 - A: Whilst we already have our My Account it currently tracks per contract account rather than site – I am looking into how the City of Fremantle is set up, as it likely has all of the data there already, however it may not be the ideal solution. We certainly have the data available it's just how we can get it to the City on a regular basis.
- Q: Can Synergy offer a non-regulated tariff to the City's smaller accounts so that the Portfolio could be negotiated as a whole?
 - A: Yes, this can be done – the only caveat is that you lose the 'security' of being on a regulated tariff
- Q: Could Synergy allow 'netting off' of PV exports from one site against loads at another? We asked Allen Gerber this one - he was going to check internally. The City would then seek to negotiate a reduced network charge with WP in order to see some value out of the Portfolio.
 - A: We could allow this alongside 'non-regulated' tariff options – however it would require some system development and build to make it all work. It is a concept I am working on, but it is not correct to say that we could implement it immediately.
 - On 4 September 2017 we have confirmed in writing that Western Power will not charge for transferring energy between different locations behind the Knutsford meter. We are awaiting Synergy's answer to this point.

Contacts:

Anazia Farla, Broker Channel Specialist, Synergy (also the City of Fremantle Account Manager)

7. phone: 6212 2001 | mobile: 0401 853 333 | fax: 08 6282 7027 | email: anazia.farla@synergy.net.au

Aidon Thomas, Sales Engineer

8. phone: (08) 6282 7209 | mobile: 0476 269 202 | email: aidon.thomas@synergy.net.au

10.3.4 Description

The energy market is in a state of transition from a traditional model of centralised power generation and distribution to households and businesses that are energy generators as well as users. The traditional model has a one-way flow of current and is very inflexible and expensive to build and maintain. Below is a representation of the traditional energy delivery model with large scale generation being transferred through the grid to end users. Users are price takers and have few alternatives to the supply of grid power and each location or building is separately metered and charged. This is a cost-plus model and in a monopoly situation can mean higher energy costs and lower service provision. This model is being disrupted by local renewable energy options that are democratising energy generation and delivery.

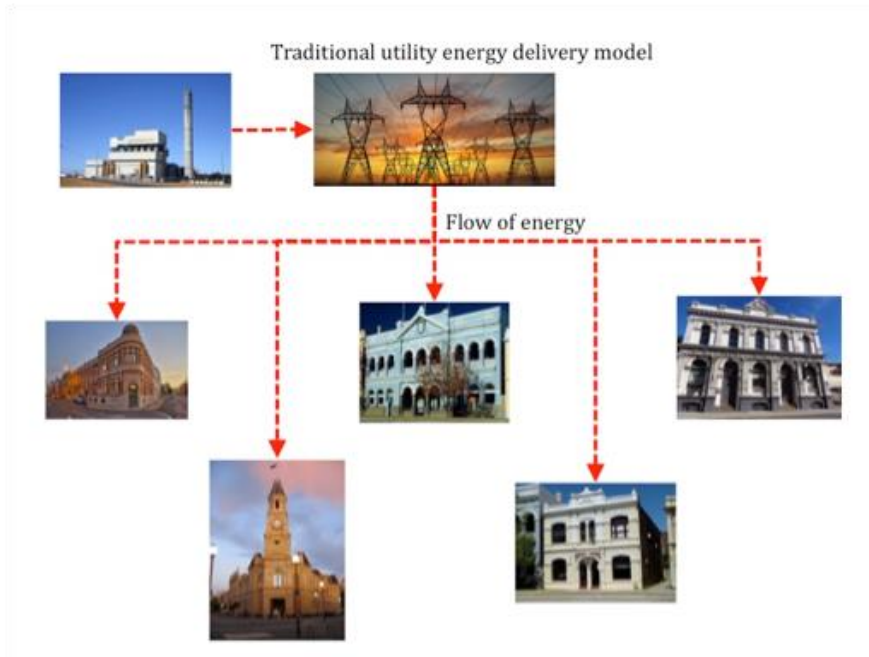


Figure 6: Traditional Energy Provision – Centralised

The new energy generation and distribution model below shows that various locations can be grouped together in a portfolio or microgrid. Each location may have generation, such as solar with batteries, and then this locally produced energy is used within the portfolio or microgrid, defined by the grey box boundary. Excess energy can be fed back into the grid so the grid is not only a battery but also provides redundancy.

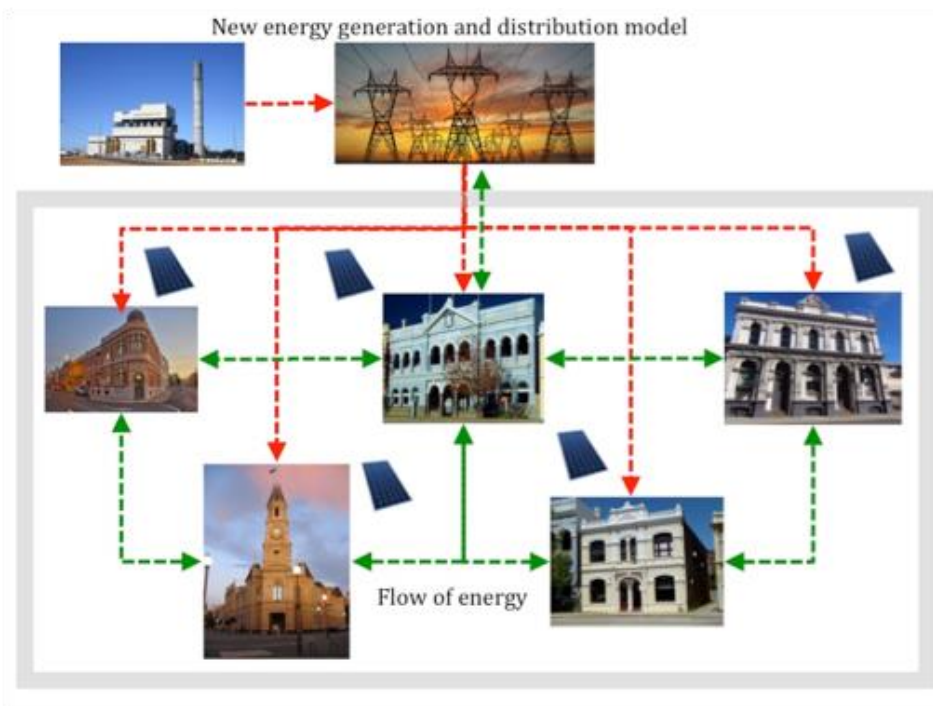


Figure 7: Today's Energy Provision – Hybrid Centralised / distributed

The portfolio or microgrid approach mentioned above shows how locally generated electricity can be consumed locally, reducing the amount of energy taken from the grid and the amount of transmission required. Overall this reduces costs, provides redundancy and improves the use of green power. The extension of this microgrid approach is the ability to also offer this service to local companies to reduce their costs while also providing a new source of revenue to the City of Fremantle.

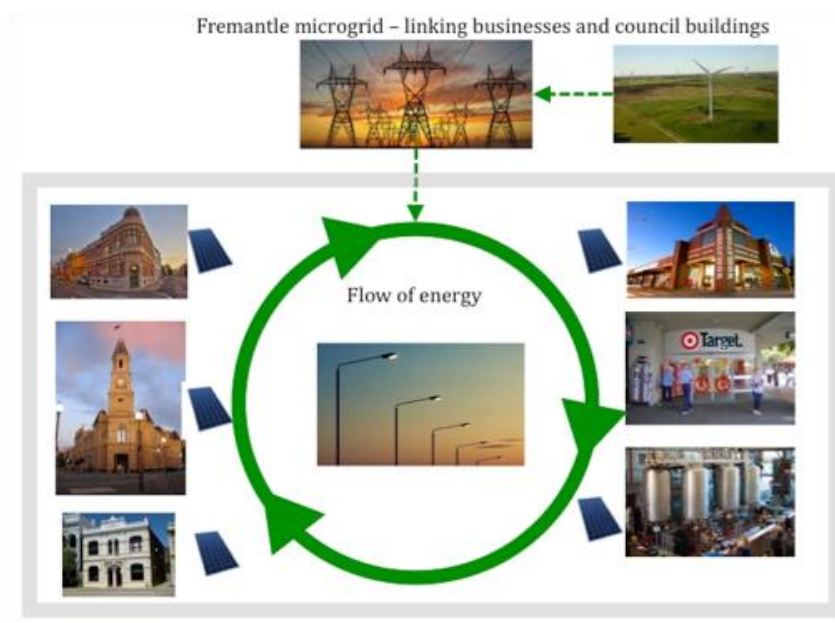


Figure 8: Tomorrow's Energy Provision – Fully distributed and sharing

Expanding on the initial portfolio/ microgrid for the City of Fremantle is to offer microgrid connectivity to local businesses as well as providing all the power to the street and park lights.

10.3.5 Detail

In a portfolio workshop meeting with Synergy on 27 July 2017, Synergy representatives agreed that netting-off existing solar PV production with current consumption was possible pending internal assessment and formal agreement by Synergy. This is a solution that Synergy only provided for large industrial companies in the past. This has significant cost savings implications for the City of Fremantle and was an important concession from Synergy.

The detail of this Management Action will emerge as Synergy and Western Power define their positions on the three main elements: Portfolio of accounts, netting-off, and pre-approvals for City PV systems.

10.3.6 Interaction with Other Actions

- Amalgamating accounts could impact the deal making leverage with a green energy supplier, by increasing the total load being met.
- The ability to net-off excess generation at a site could change the decision on PV system sizing at a given site.
- A simplified approvals process for City PV systems could impact the commercial decision making on viability of a given PV system.

- The en-masse approvals process could enable the FLC PV system back online, although this is far from certain.

10.3.7 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the ‘value’ of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

The value of the Portfolio approach is partly about simplification but could also create financial value if enabled by the utilities.

One opportunity is around the increased bargaining power of having a larger, amalgamated account to offer the market. This depends on the Portfolio being effectively ‘contestable’.

The opportunity to ‘net off’ excess PV production at one site against a load at another, could also create a saving if permitted. The value here is dependent on the amount of excess onsite generation available, the network charge to move that excess energy to another site, and level of tariffs for selling into the grid versus self-consuming. The table below shows that, based on assumptions about current levels for the various elements of the business case, netting off does not create value for the City, however a change to the network charge, of the tariffs, could change this result if the City has the appetite to negotiate it. A 50% reduction in network charge, negotiated with Western Power as a trial for a number of years, changes the outcome significantly, while as little as 2% network charge discount moves the situation to break-even or better.

Table 11: Analysis of Portfolio Value

Metric	Value (current position)	Value (negotiated position – 2% network discount)	Value (negotiated position – 50% network discount)	Method
Total electricity consumption of buildings considered for PV systems (Cat A buildings plus Ken Allen and Hockey Club) [kWh]:	3,814,061			[A]
Total modelled PV production from these buildings [kWh]:	732,864			[B]
Nett consumption with netting-off [kWh]:	3,081,197			[A-B]
Cat A building load met by PV WITH netting-off:	19%			[B / A]
Assumed daytime proportion (proportion of load that can be met directly by PV):	80%			Assumption
Sum of export PV electricity produced at all sites [kWh]:	287,716			[B - daytime loads met by PV] = [C]

Metric	Value (current position)	Value (negotiated position – 2% network discount)	Value (negotiated position – 50% network discount)	Method
Building Load met without netting-off [kWh]:	445,148			[B - C] = [D]
Cat A building load met by PV WITHOUT netting-off:	12%			[D / A]
Assumed tariff for grid elec (\$/kWh)	\$ 0.21			t-import
Value of exported PV electricity if netted off	\$ 60,420			[C * t-import] = [E]
Network Charge to carry electricity between sites (\$/kWh)	\$ 0.13 ²⁵	\$ 0.1298	\$ 0.07	t-network
Total network charge to share export electricity (to achieve netting off)	\$ 38,094	\$ 37,332	\$ 18,702	[C * t-network] = [F]
Assumed feed-in tariff for exports not netted off. (\$/kWh)	\$ 0.08			t-feedin
Value of exported PV electricity (2 assumed \$0.08cents/kWh) [this could be as high as 18cents/kWh depending on arrangement with Synergy]	\$ 23,017			[C * t-feedin] = [G]
Net annual value of netting-off:	(\$ 691) loss	\$ 71 gain	\$ 18,702 gain	[E - F - G]
NOTE: this assumes that ALL proposed PV systems are installed (a 10-fold increase on the current amount of installed PV)				

(i) Assumptions

- The costs of the portfolio or micro grid could be financed through a variety of government or private sector sources. Government sources include the Clean Energy Finance Corporation, ARENA, and City Deals (part of the Federal Government's Smart Cities program).
- The Plan is based achieving 100% renewable energy consumption for the entire City of Fremantle portfolio.

²⁵ Information from City of Fremantle.

(b) Environmental Analysis

- This is mainly a governance change, but the enabling of increased use of renewable energy will have positive environmental effects.

(c) Social Analysis

- Expected to reduce costs, improve energy efficiency and provide new alternatives for storing and using power behind the meter in Fremantle.

(d) OPL review

The move to a 100% renewable energy supply is a core objective of OPL.

10.3.8 Risk Review

This is an ongoing pilot project and risks need to be continuously evaluated.

10.3.9 Program for Implementation

Despite some complexity of implementation, this is a stage 1 action as it needs to be resolved to determine any impact on other actions.

10.3.10 Benchmarks and other measures to be included in reporting

A formal communication from Synergy or Western Power should be recorded in the Energy Plan Status Update, as well as proposed next steps based on its content.

10.3.11 Summary of Management Action

Action	Energy Portfolio
Final Recommendation	1) Resolve with Synergy and Western Power whether the City Electricity accounts can be amalgamated and treated as a single, contestable portfolio. 2) Resolve with Synergy whether 'netting-off' between sites can be enabled, and whether Western power will discount the network charges to make this attractive. Network usage charge behind the Knutsford transformer could be as low as a few cents per kWh. 3) Resolve with Western Power whether PV systems on City facilities can be pre-approved en-masse. 4) Solar PV suppliers are often able to provide financing solutions and these need to be considered to ensure the best use of the CoF available cash reserves.
NPV / LCoE	TBC
Renewable Energy (kWh/year)	na (these are platforms, rather than energy generation)
Emissions (+/- Tonne CO2e/year)	na
Leadership value	This approach would be of strong interest to LGAs with non-contestable sites.
OPL impacts	General compliance OPL's principles around better management of resources.
Plan Stage to implement	Stage 1

Interaction with other Actions	<ul style="list-style-type: none"> •Amalgamating accounts could impact the deal making leverage with a green energy supplier, by increasing the total load being met. •The ability to nett-off excess generation at a site could change the decision on PV system sizing at a given site. •A simplified approvals process for City PV systems could impact the commercial decision making on viability of a given PV system. •The en-masse approvals process could enable the FLC PV system back online, although this is far from certain.
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10.4 Management Action: Fremantle Leisure Centre – Energy Systems

10.4.1 Subtitle of Management Action

Understanding the performance of the cogeneration system, and the potential to re-connect the existing PV system that is, supposedly, currently not approved for connection by Western Power.

10.4.2 Summary of Recommendations

(a) Disconnected PV System

1. Submit an application to connect the system as is – an experienced PV installer/supplier should be engaged to complete this application as they will have the best chance of allaying any concerns at Western Power.
2. Based on feedback from the application, either the system is re-connected as is, or works that are required to resolve any issues raised by Western Power can be priced and a final decision on viability of the current system can be made. The replacement value of this system is in the order of \$70,000. Based on data available for the overall site, the PV system, in combination with the cogen system, would rarely result in generation exceeding consumption, so exports would be minor. An automated switch to prevent export has been costed in the order of \$45,000, but a more cost-effective approach may be possible. If this satisfies any residual Western Power barriers to reconnection, it would be a worthwhile investment given the minor resulting losses in energy production.
3. If the system is not considered viable, then an alternative may be to consider the option of developing an ‘off-grid’ EV charging station powered directly from the system.
4. As a last resort, salvage should be considered before the system is too old to be of value. There are specialists in this field emerging, although it is early days as most solar systems have been installed in the last decade, so will be mostly be operational for the next 15 years at least. One contact found that may be useful was: Reclaim PV Recycling Pty Ltd based in South Australia [<http://reclaimpv.com/>]

(b) Geothermal/Cogeneration System

- 1) Complete a full audit of the last year of operation of the geothermal/cogen system to determine performance, and assess the real value of the system.
- 2) Review the service level contract to determine whether service levels are being met by the provider.

- 3) It is important that the City of Fremantle has local engineering and programming support to ensure maximum availability and utilisation of the generator. It is recommended to contact the current service provider to identify local engineering and programming support for the future.

10.4.3 Status of Management Action

This Management Action has two main parts:

- 1) The PV system application to connect is apparently being prepared by the City. Again, it is recommended that an experienced PV installer/supplier be engaged to review the application.
- 2) The initial audit of the cogen system performance can commence as soon as there are resources available.

Tony Strickland, Manager Sustainable Services & Projects, City of Fremantle, has been the main contact for this Management Action.

10.4.4 Description

(a) Disconnected PV System

This system is reportedly 30kWp. It was installed in 2009, and disconnected when the cogen was being connected in 2013.

The system sits on the acrylic sheeting that clads the metal frame roof of the main pool building.

(b) Geothermal/Cogeneration System

The Fremantle Aquatic Centre co-generation and geothermal heating project combines a gas fired Cummins engine with a shallow aquifer geothermal bore approximately 156m deep. The bore utilises warm water (approx. 26°C), from the Leederville Aquifer.

It is clear that since the implementation of the co-generation and geothermal project, the gas consumption for water heating has substantially decreased gas costs. The major issue identified has been around ongoing repairs and maintenance costs. Although EMC (Carnegie Clean Energy) engineered the system, engineering and maintenance support is in Brisbane.

We were also informed that there is one person who knows how to program the generator and he is on long service leave. This presents a significant operating risk and reduced reliability.

We were informed that the City increased the maintenance budget by an additional \$10,000 in 2017 however approximately \$60,000 has been spent on increased repairs and maintenance which reduces the benefit from the entire system.

We were also informed of issues with the heat exchanger in the geothermal heating project. The heat exchanger requires significant maintenance compared to similar projects elsewhere. This also increases the overall operating costs for the system.



Figure 9: Clockwise from top left: Solar PV panels, the co-generation plant and the geothermal plant.

We also sighted the solar PV array and it appeared to be in working order although has not operated for at least five years. There is sufficient space for additional solar panels.

10.4.5 Detail

(a) PV System

No documentation has been provided regarding any previously refused application to re-connect the 30kWp PV system at the Fremantle Leisure Centre. Given that nothing to the contrary appears to be documented, it is recommended that the City submit a fresh application to Western Power. An experienced PV installer/supplier should be engaged to complete this application as they will have the best chance of allaying any concerns at Western Power, and will be well positioned to recommend and price solutions to any Western Power conditions on approval.

The system was reportedly installed in 2009, so it is likely that it would not meet today's technical standards. If this is a condition of approval, then upgrading the system to comply is unlikely to be cost effective. The application needs to be clear that the system was approved and was operating for around 5 years prior to disconnection. And that disconnection was a necessary part of the cogeneration project, but that the PV system was always intended to be reconnected once that project had been commissioned and was running within acceptable performance bounds.

One condition that is frequently imposed is 'zero export', generally requiring for larger, non-residential systems that switchgear be installed to ensure that there is no export. If this condition is imposed then the cost of installing such equipment needs to be considered. Based on the 2017 year to 28 July, losses of PV

generated electricity due to export blocking would be approximately 1%, and the annual financial loss would amount to approximately \$30 in lost feed-in credits based on Synergy values. This would be lost if export blocking switchgear was installed.

See the table below regarding the amount of theoretical export if the PV system had been operating in recent months (negative values are imports from the grid, which predominate overwhelmingly).

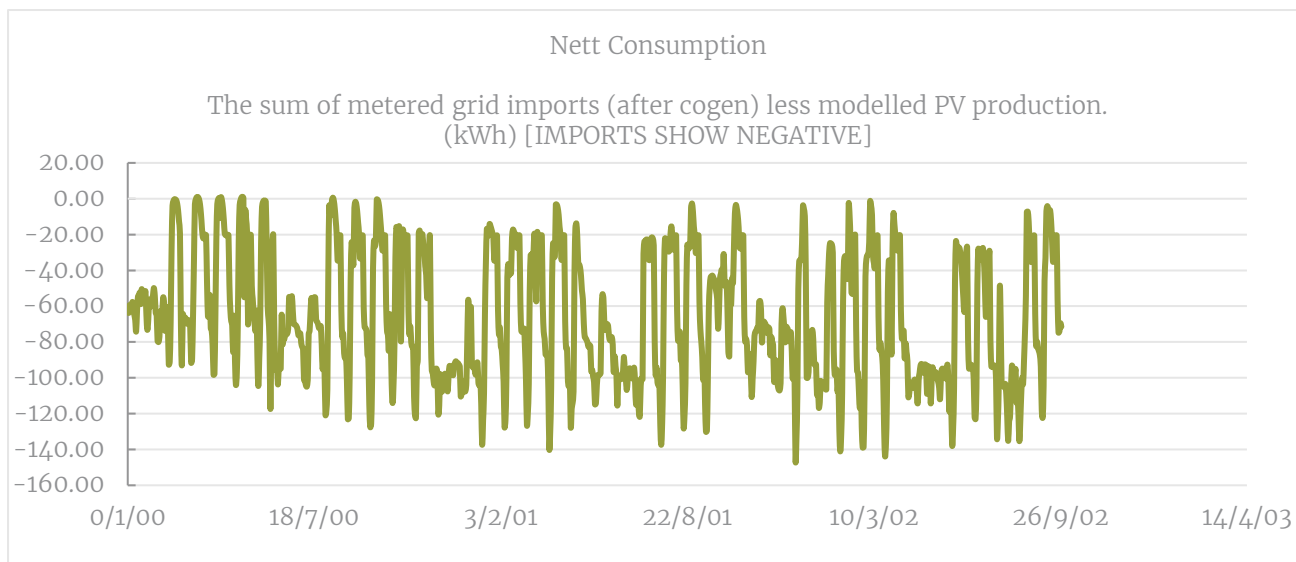


Figure 10: Nett Exports for April 2017 if PV had been connected (negative values are Imports)

Ideally, the PV system can be re-connected with minimal cost. There is a separate Management Action to create a portfolio of City energy accounts, an element of which is to enable ‘netting-off’ of export from disparate sites against common loads. If there are costs are estimated for reconnecting the PV system, then they may be mitigated if the netting-off arrangement is in place. There are a number of barriers to netting-off between City sites but this option should be exhausted prior to investing heavily on zero export switchgear.

(b) Geothermal and Cogeneration System

Taking a particular day, in this case January 5, 2017, helps emphasise the behaviour of the systems, and the potential impact of reconnecting the solar PV systems. See the figure below that indicates load met by the grid, load met by the cogen unit, gas consumed in the cogen unit (refers to right hand axis of the chart), and theoretical PV electricity generation if the system had been operational.

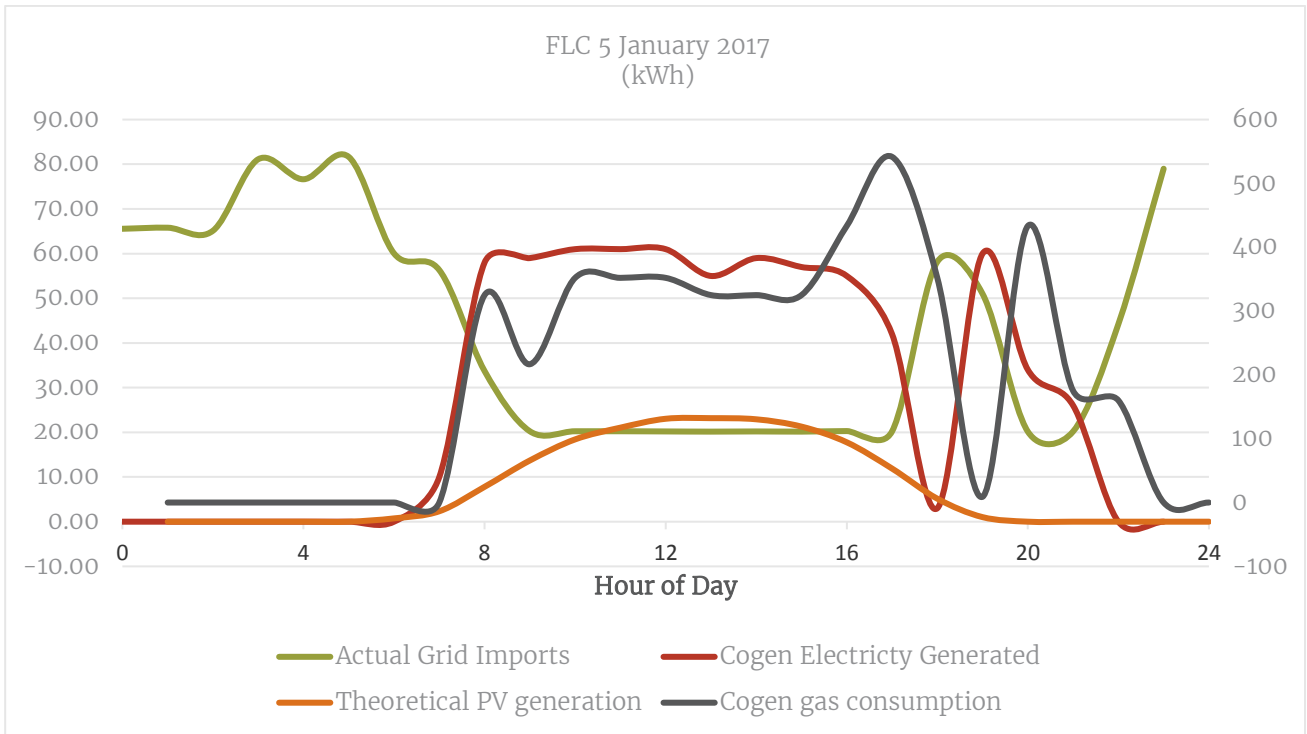


Figure 11: Summary chart of FLC energy sources

Observations:

- The PV Production line remains below the grid import line for most of the day, exceeding it in the middle of the day but not by a large amount (2-3kW). Note that this is one of the highest solar production days of the year.
- The cogen unit appears to be operational during daytimes only - approximately 8am to 10pm. This has been confirmed in a site visit by the facility manager and from a note on the cogen unit.
- Imported electricity meets the night-time load, which appears to remain at a similar total level throughout the night. This too was confirmed in the site visit; Pumps run through the night to maintain filtering and heating. There is, according to facility managers, a need for heating in the night, for much of the year. These night-time heat and power loads could be met by the cogen unit if it is thought to be cost effective. This cost effectiveness needs to consider reportedly high maintenance costs, which would increase with longer hours of operation, as well as the cost of gas compared to the off-peak electricity tariff, which is reportedly in place.
- Data on other gas use at FLC is unavailable through Greensense. It was reported during the site visit that the staff are recording gas use manually from meters on a regular basis (at least once a week). Once this information can be reconciled against the electrical data, the performance of the overall system can be better understood. Data on the overall corporate gas use for the City of Fremantle was provided by the City. The information contained is difficult to interpret with confidence and, in fact, appears incomplete. The figure below is based on the data provided.

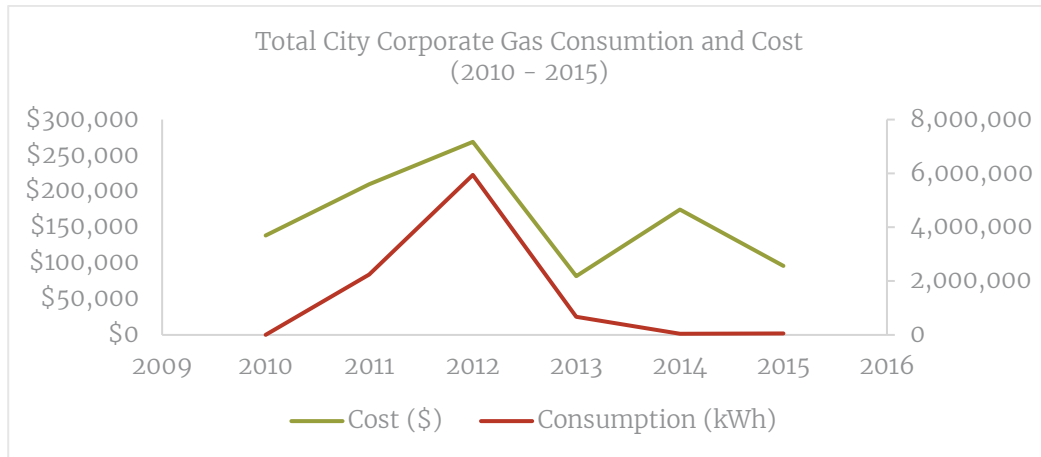


Figure 12: Overall City of Fremantle gas consumption and cost data (source: CoF)

10.4.6 Assumptions

It is assumed that the Greensense data is complete and correct.

10.4.7 Interaction with Other Actions

The leisure centre generation would be included in the energy portfolio project.

10.4.8 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial

The annual value of electricity generated by the PV system, on the basis that, as per available data, virtually all would be used onsite, is approximately \$10,000 per year. This is based on an assumed tariff of 21 cents/kWh.

Quotes for zero export equipment have not been obtained but an indicative cost of \$15,000 was suggested by one engineer.

Maintenance costs and uptime of the cogeneration system could be improved with local engineering and technical support, although this may not be available for relatively specialised equipment.

(b) Environmental

Given that the emissions from electricity consumed at the Leisure Centre are already being offset annually, there would be no nett emissions reduction from reconnecting the PV system. However, directly meeting electricity requirements from an onsite renewable energy represents a more immediate strategy, with less risk in terms of accurate calculation of emissions footprint and real offset value of a deemed offset certificate. It also means that those offsets that would be no longer required will be available to others.

The environmental downside of not reconnecting the system should also be considered; the lost generation while the system is disconnected, and aging, is a waste, as is the material waste of system components if they cannot be effectively redeployed, or reused.

(c) Social

The system is highly visible and displays the City’s commitment to reducing the environmental impact of its energy supply. If people come to understand that it is, in fact, not functioning, this could have an exaggeratedly discouraging effect on their impression of renewable energy systems. The story of a renewable energy system that has failed before its time can provide political capital to groups that seek to discredit such systems as viable in the energy sector.

(d) OPL

Reconnecting the FLC PV system is strongly in line with the principles of Zero Carbon and Zero Waste, but is also consistent with the deeper intent of the framework around achieving ‘real’ grounded change, rather than high profile initiatives that don’t then become integrated into an ongoing sustainable mode of operation.

10.4.9 Risk Review

There are significant and ongoing risks of catastrophic failures in the co-generation plant and ongoing maintenance cost issues with the geothermal. These issues may be mitigated with local expertise.

Causal Factor	Resulting risk	Possible Impact	Likelihood	Response
PV Installation is not compliant with Australian Standard or Western Power requirements	Non-completion/connection of system.	System may not be reconnected until problem rectified.	High	Engage experienced PV contractor to submit application to optimise chances. Tender zero export switchgear if required.
Network structural issues preventing the PV systems from being connected to the grid	Leads to abandonment of the project	Connection Application submitted to Western Power would be rejected	Medium	Review progress on the ‘portfolio, netting-off’ management action in this plan, as this may provide an alternative.
Energy efficiency is improved at the FLC.	Load is reduced, so blocked exports from re-connected PV system increase.	There is no net loss to the City but the annual value of the PV system reduces.	Medium	The FLC shows a continuous load profile that does not reduce significantly at night, Energy efficiency programs should focus on the night-time load as this is not met by PV or the cogen.

10.4.10 Program for Implementation

This is a Stage 1 Management Action, with hold points depending on some other Management Actions being implemented, or not.

- 1) Submit a connection application to Western Power.
- 2) Observe any conditions and obtain costs to upgrade if required. Determine viability based on financial information provided here.

3) If viable, complete re-connection.

The following may be considered Stage 2 actions:

- Hold #1: If reconnection is not viable based on costs, review progress on the portfolio approach recommended elsewhere. If ‘netting-off’ is likely to be approved under the portfolio framework, then exporting from the FLC site would, in principle, be permitted, and expensive zero export equipment could be avoided.
- Hold #2: If the portfolio approach is not progressing, then consider other opportunities for the system, such as direct DC charging for EVs by setting up a linked EV charge point in the FLC carpark.
- If no other option is determined viable, then salvaging the system at the earliest opportunity is recommended as the system will continue to devalue over time.

10.4.11 Benchmarks and other measures to be included in reporting

The progress of application for connection of the PV system, resulting outcome, and decisions on further action should all be recorded in the Energy Plan Status Updates.

The PV system is expected to generate 49,000 kWh per year, with 99% being absorbed onsite, if re-connected.

10.4.12 Summary of Management Action

Action	Fremantle Leisure Centre – Energy Systems
Final Recommendation	Apply to connect the existing FLC PV system. Engage an experienced PV contractor to assist. Complete a full audit of the last year of operation of the geothermal/cogen system to determine performance, and assess the real value of the system.
NPV / LCoE	TBC – unknown until the outcome of the PV connection application, and any resulting costs are known. Value of energy produced will be approx. \$10K per year.
Renewable Energy (kWh/year)	49,000 kWh (from a restored 30kWp PV system)
Emissions (+/- Tonne CO2e/year)	-40 Tonne CO2e/year (compared to grid power)
Leadership value	High given the high visibility of the system.
OPL impacts	OPL’s overall philosophy is around continuous improvement, which includes maintenance and ongoing commitment to outcomes.
Plan Stage to implement	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> • Annual Energy Reports: The <i>Energy Plan Status Update</i> to be an appendix to the <i>Annual Energy Report</i> if implemented. • Energy Account Portfolio: ‘netting-off’ may impact the requirement for zero-exports.

10.5 Management Action: Energy Efficient Buildings

10.5.1 Sub-title of Management Action

Adding energy auditing to the City's Building Audit process.

10.5.2 Summary of Recommendations

- Add energy auditing to the Building Audit process.
- Create an Energy Check process for tradespeople on City sites.
- Develop building type energy consumption benchmarks with WALGA and others.
- Develop a game layer for different facilities to compete on energy performance, incentivised by a share of the savings or similar. Competition between LGAs could also be supported by WALGA.

10.5.3 Status of Management Action

This Management Action requires that a provider be identified for the recommended building energy audits. It has been suggested elsewhere that, if an officer is appointed to implement the Energy Plan Stage 1, then they should have some energy auditing experience and may be capable of performing the first round of audits.

Sam Bryce, Manager City Assets, and Adelaide Wood, Team Leader Facilities and Assets, City of Fremantle, have been the main contacts for this Management Action.

10.5.4 Description

The City's Building Audit process may result in changes and upgrades that lead to energy performance improvements, but there is currently no systematic search for opportunities to improve energy efficiency. An energy audit component could be added to the Building Audit scope.

There is also opportunity to have experienced trades people do some basic energy checks while they are working on a given City building.

The development of benchmarks for building types will assist in identifying buildings that may benefit from energy auditing. This has been discussed with WALGA, who were already interested in the idea. This is an ongoing discussion to be resolved.

(a) Types of Energy Audit

The Australian Standard (AS/NZS 3598:2000) outlines what an energy audit should cover. The standard specifies 3 levels of energy audits:

A **level-1 energy audit** is a lower cost, entry-level assessment for your site providing a lower level assessment of energy use and energy saving opportunities. It is useful as a first step investigation into energy saving opportunities.

- Accuracy of Energy Savings Predictions: should be within $\pm 40\%$.
- Outcome: an abbreviated report with a short list of key energy saving opportunities with rough figures on savings and costs.

- Next step: you should now have a better understanding of your sites energy consumption and options to reduce your energy consumption and costs. Further investigation is required to properly cost and assess options. This may be done by seeking quotes from suppliers or conducting a level-2 audit.

A **level-2 energy audit** provides a more detailed assessment of your site's energy consumption and a more comprehensive analysis of energy and cost savings. It is intended for sites that have some knowledge of energy efficiency and require a detailed assessment of opportunities to reduce their energy consumption. A level 2 energy audit includes a number of items not included in a level-1 audit such as: identifying how and where energy is used, a load profile analysis (instantaneous demand profile for your site), developing an energy performance indicator (e.g. MWh/unit), and measuring light levels to check if areas are over lit and wasting energy.

- Accuracy of Energy Savings Predictions: should be within $\pm 20\%$.
- Outcome: a full analysis and report providing a prioritised list of energy saving opportunities with estimates on costs and savings.
- Next step: you should now have a good understanding of your sites energy consumption and a prioritized list of options to reduce energy consumption and costs. Now you need decide what options you would like to pursue, seek quotes from at least 3 suppliers, re-assess costing and implement.

A **level-3 energy audit** provides the most comprehensive assessment of energy consumption and a detailed economic analysis of energy saving opportunities. It may cover an entire site or may focus on one area or process. It requires energy metering and logging which may significantly increase the cost of the energy audit.

- Accuracy: should be within +10% for costs and -10% for benefits.
- Outcome: an in-depth analysis and detailed report providing a firmly costed list of energy saving opportunities.
- Next step: you should now have all the practical and financial information required to justify implementing an energy saving opportunity. Time to implement.

10.5.5 Detail

Two energy audit actions are proposed, one to be made part of the Building Audit process, and one to be added to the scope of works of tradespeople working on City sites.

(a) City Tradespeople – Energy Check

This is not an energy audit as such but would have some of the benefits of a Level 1 Energy Audit.

Certain trades (e.g. electrical and HVAC) will be supplied with a short checklist to enable them to record a basic check. This could be incentivised by a small payment on return of a completed checklist, or could form part of the engagement agreement with the tradesperson. Instruction on the checklist will include:

1. Please take a photograph of the main switch board with the utility meter: this is to provide information and an indication of the age and state of the electrical infrastructure, and the space

available in the board for additional items. Please email the photograph to energy@fremantle. With the address of the building.

2. Is the lighting in the building predominantly 1) Fluorescent tube (old) 2) fluorescent tube (newer) 3) compact fluorescent 4) LED 5) Other: ___ 6) Could not observe.
3. Does the building have a photovoltaic system installed? Does it appear to be functional (e.g. from checking the inverter screen)?
4. Where any potential energy saving opportunities observed?

(b) Building Audit - Energy Review

This review will form part of the City's Building Audit schedule and will be aligned to a Level 2 Energy Audit.

- A 3-year program of having a trained energy auditor accompany the building audit team on inspections. For office buildings, this should include generating a Building Energy Efficiency Certificate (BEEC), so a suitably accredited auditor should be engaged.
- The auditor will provide a report and make recommendations for improvement with an indicated benefit from each improvement.
- The recommendations of the audit that involve proposed works for improving energy performance should be listed on the Defects Schedule for follow up as deemed appropriate by the responsible officer, based on budget, timing, and expected benefit based on the audit report.
- The last 5 years of annual energy consumption should be recorded in the Building Data schedule so that trends and recent anomalies can be identified ongoing.

10.5.6 Assumptions

It is assumed that responsibility for collating the results of energy auditing will be part of an officer's role, so that opportunities for energy efficiency can be captured and acted on by the City.

10.5.7 Interaction with Other Actions

The following Management Actions that are recommended in this Plan may impact this Management Action:

- Energy Plan Status Updates: progress on creation of the necessary documents and changes to procedures to be recorded in the Energy Plan Status Updates.
- Annual Energy Report: This report will have a section dedicated to recording which buildings have been audited, which Energy Checked, and what opportunities for energy efficiency were identified. This section should also note how many audits and checks were carried out in the previous reporting period.
- Data reform: part of the audit process will be to align meter and account numbers to buildings, and check that consumption data is being collected correctly.

10.5.8 Triple Bottom Line and One Planet Living (OPL) Analysis

(a) Financial Analysis

This section is about finding opportunities and so is inherently uncertain in terms of outcomes. However, it would be unusual that an organisation could not achieve 10% or better energy savings if a comprehensive scheme is put in place.

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Total Energy Consumed by buildings in the Energy Plan scope	3,800 MWh
Value (in 2017) of 10% saving by 2025	\$80,000 / year by 2025
Cost of Energy Check Assume 30 mins onsite, 1 hour processing	\$225
Cost of energy audit addition to Building Audit Assume 5 hours including site visit and analysis	\$750
Cost of implementing energy efficiency projects over the 8 years of this Plan	\$480,000
Average simple payback for anticipated energy efficiency projects	3 years

(i) Assumptions

The figures above hinge on a number of assumptions:

- Energy tariff: 21cents/unit (including carbon offsetting)
- Staff/trades hourly rate: \$150/hour
- Works will generally be completed when the City budget allows, therefore financing analysis is not based on debt.

(b) Environmental Analysis

The unit of energy that you don't use is generally considered the lowest environmental impact. However, many energy efficiency projects require the installation of equipment, so materiality and waste should be considered.

For example, changing out near-new light fittings for more efficient light fittings might make sense in terms of energy but could be wasteful. Aligning upgrades of this kind with the maintenance schedule is a preferred approach in many cases.

(c) Social Analysis

There is great maturity in the public understanding of energy efficiency and a strong sense of waste. Explaining how waste has been reduced can be inspiring to people.

(d) OPL review

Energy efficiency in buildings is inherent in an effective implementation of the Zero Carbon principle.

10.5.9 Risk Review

Causal Factor	Resulting risk	Possible Impact	Likelihood	Response
Lack of skilled capability to carry out audits	Audits and Checks do not identify opportunities	Lack of impact, abandoned action	Medium	During the period of the Plan, City officers involved in Building Audits receive energy audit training OR an external provider is engaged. The effectiveness of audits will improve with time, so a degree of robust commitment by the City is required.
Cheap energy sourced by City reduces incentive to efficiency	Less impetus for efficiency projects.	City consumes more energy, although that energy is low cost and 'green'.	Low	Although the City may find a cost-effective contract for energy, it is unlikely to compete with energy efficiency projects until the 10% energy reduction has been achieved. City to set target for energy reduction across all buildings by 2025 to act as a separate driver.

10.5.10 Program for Implementation

This is a Stage 1 Management Action, with hold points depending on some other Management Actions being implemented, or not.

- 1) Energy Check should be developed, in collaboration with tradespeople, and implemented immediately.
- 2) Hold #1: the energy audit addition to the Building Audit process should be developed in an integrated way. The roll out would be concurrent with the Building Audit program.
- 3) Review program: Once the City has negotiated the recommended large scale renewable energy supply initiative, the resulting cost of energy should then be used as part of assessing future efficiency projects.

10.5.11 Benchmarks and other measures to be included in reporting

- Data: a clear before and after case should be identified, including the method for accessing the required data, must be part of the documentation of each energy efficiency project.

- Building type benchmarks: The City to work with WALGA to develop benchmarks that can be tested through the efficiency projects.

10.5.12 Summary of Management Action

Action	Energy Efficient Buildings
Final Recommendation	<p>Add energy auditing to the Building Audit process.</p> <p>Create an Energy Check process from tradespeople on City sites.</p> <p>Develop building type energy consumption benchmarks with WALGA and others.</p> <p>Develop a game layer for different facilities to compete on energy performance, incentivised by a share of the savings or similar. Competition between LGAs could also be supported by WALGA.</p>
Financial value	Saving \$80,000 per year by 2025, costs estimated \$480,000 over that period.
Renewable Energy (kWh/year)	10-20% building energy (approx. 400,000 kWh/year)
Emissions (+/- Tonne CO2e/year)	-400 Tonne CO2e/year
Leadership value	Reduce waste of energy
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓]
Plan Stage to implement	Stage 1
Interaction with other Actions	<p>Energy Plan Status Updates: progress on creation of the necessary documents and changes to procedures to be recorded in the Energy Plan Status Updates.</p> <p>Annual Energy Report: This report will have a section dedicated to recording which buildings have been audited, which Energy Checked, and what opportunities for energy efficiency were identified. This section should also note how many audits and checks were carried out in the previous reporting period.</p> <p>Data reform: part of the audit process will be to align meter and account numbers to buildings, and check that consumption data is being collected correctly.</p>

10.6 Management Action: Street and Park Lighting Upgrades

10.6.1 Subtitle of Management Action

Upgrading both the City's and Western Power's public realm lighting infrastructure to improve both energy and cost performance.

10.6.2 Summary of Recommendations

1. Resolve contestability with Synergy
2. If streetlight electricity is contestable, add to the City's portfolio and negotiate green energy supply.
3. If not contestable, then the amount of streetlighting electricity should be calculated and renewable energy certificates (STCs and LGCs) procured to 'cover off' the amount, so that the City can then claim to be running streetlights on 100% renewable energy.
4. Trial LED street lights (e.g. current Market St upgrade) and adaptive lighting, and report internally on lessons learned to inform a larger roll-out as more LED options enter the Western Power catalogue in the next year.
5. Once Western Power release their updated catalogue of LED light options, Synergy can finalise their costs. Once this occurs then a complete replacement program of all lights with LEDs is recommended. The costs, payback period and financing can only be completed once the Synergy charges are finalised.

10.6.3 Status of Management Action

A trial of LED lighting along Market Street has been instigated. This should be treated as a trial, with costs and savings carefully monitored so that future business cases for LED upgrades can be well informed.

Daniel Sharp, Engineering Projects Officer, City of Fremantle, has reviewed this Management Action.

10.6.4 Description

The current streetlights installed throughout the City of Fremantle are a mixture of Metal Halide, High Pressure Sodium, Mercury Vapour and Compact Florescent. These traditional streetlight bulbs are not as energy efficient as modern Light Emitting Diodes (LED) and need to be replaced more often. This means the costs of street lighting for the City of Fremantle is higher than it needs to be. Street lighting and park lighting around the City in 2016 cost \$825,549 or 50% of total electrical costs in the financial statements. It is the largest single utility cost the City of Fremantle incurs.

In FYE2016, Fremantle street lighting consumed approximately 2 gigawatt- hours of electricity.

Using a comparative project, the Warrnambool City Council in Victoria is replacing approximately 2,000 residential street lights with LED technology and is forecast by the Clean Energy Finance Corporation to reduce lighting operation and maintenance costs by 68 per cent.²⁶²⁷ If these savings were achieved in Fremantle this

²⁶ <http://www.cleanenergyfinancecorp.com.au/case-studies/council-saves-on-street-lighting-costs.aspx>

²⁷ Synergy are unable to split energy and maintenance costs due to their accounting system. This was discussed in depth. Therefore comparable projects are the most appropriate reference point.

would mean **cost savings of approximately \$561,373 per year or 26% savings on the City's utility bills. Over the 20-year life of LED lighting this would be an estimated discounted cost savings of \$8.4mil.** It should be noted that these cost savings would likely be captured over time as it is dependent upon the type of bulb replaced, the Synergy tariffs, the operating parameters from Western Power and the source of the generation, be that the City of Fremantle or from the grid. The Fremantle Port Authority recently installed LEDs at Victoria Quay and has confirmed significant cost savings. Discussions with GreenBank in the UK also suggested savings of energy and maintenance of approximately 60 - 70%.

Western Power owns the majority of the City of Fremantle's and Western Australia's street lighting infrastructure and has little to no incentive to introduce more energy efficient technologies given that it may not recognise the economic or community benefits in the current monopoly environment. All Western Power charges are on a cost-plus basis that provides a perverse incentive to increase rather than reduce costs. It may be that Western Power may even be worse off financially as a result of the lower electricity consumption, maintenance costs and extended operating life associated with the more efficient technology.

Although Western Power introduced a 22W LED into their product range it is primarily suitable to meet Category P standards – which relate to low volume traffic roadways and other outdoor public spaces. Higher wattage LEDs are required for other locations such as Category V standards – which are used for high traffic volume roadways where the requirement of motorists is dominant.²⁸ Discussions with Western Power have been positive and we understand that they are expecting to introduce additional LED products later in 2017 and these should be part of the comprehensive streetlight replacement program.

LED street lights were recently installed by Horizon Power in Karratha and Port Hedland as part of the Pilbara Underground Power Program so there is a local Western Australian comparative project available. The Fremantle Port Authority has also installed LED streetlights at Victoria Quay.



Figure 13: LED streetlights at the Maritime Museum near E-Shed. Installed by the Fremantle Port Authority

An example of a City converting from traditional lighting to LED is Warrnambool City Council that reduced street lighting costs by 68%. The Clean Energy Financing Corporation, which provided approximately \$600,000 towards the project, has backed street lighting upgrades for several other councils. In Victoria alone, the street lighting upgrade opportunities represent an investment of more than \$100 million.

²⁸ <http://walga.asn.au/getattachment/About-WALGA/Structure/State-Council/Agenda-and-Minutes/State-Council-Agenda-May-2017.pdf.aspx> Page 89

In WA the Rural & Regional LED Street Lighting Retrofit saw several towns in the Pilbara replace aging street lighting with LED, which reduced energy costs by a minimum of 30% (2012 technology) and the investment was repaid in just over 5 years. Today the same project would realise higher energy efficiency returns and faster payback periods due to advances in technology.

Also regarding LED lighting, Ausgrid recently completed a study comparing a mixture of 62 mercury vapour and fluorescent globes to LED across a variety of locations in the trial.²⁹ This study found that LEDs were on average 57% more energy efficient than the traditional globes, had better lighting characteristics and were preferred by residents.

“LED street lighting delivers far superior colour rendering compared with traditional street lights and improves safety by making it much easier for drivers to recognise hazards and pedestrians. And although they suffer some degradation, LED lights don’t progressively degrade to the poor performance levels of mercury vapour lights.”

Furthermore, with LED lighting, residents can maintain a sense of security while reducing light pollution, which affects some people’s ability to sleep.

10.6.5 Street lighting regulatory environment

WALGA recently published a technical paper on street lighting and the main concerns were³⁰;

- The regulatory environment – Western Power’s ownership of the majority of the street lighting network has limited opportunities for Councils to adopt new and more efficient technology and take advantage of alternative service offerings. Further, Western Power has control of the poles that street lights are attached to and do not allow third parties to access these, which prevents Local Government from using third party service providers.
- Non-contestability – At present, only those customers within the South West Interconnected System that are consuming more than 50 megawatt hours (MWh) of electricity a year (approx \$14,000 per year or an average of 137 units per day) can choose their electricity retailer. Given that individual streetlights are classed as separate exit points, they consume less energy than is required to be eligible for contestable electricity supply – using a maximum of around 2 MWh per year.
- Transparency – Local Governments have no visibility of what contributes to the cost of providing street lights as a service in each luminaire class.
- Australian road lighting standards – The Australian Standard for street lighting previously did not provide for LED technology.
- Service standards – At present, the only service standards for street lighting that are included in the current Access Arrangement relate to repair timeframes. There are no standards that relate to other issues such as light levels and spillage.
- Funding – Undertaking a bulk replacement is a costly and resource intensive exercise that can run into the millions of dollars.

²⁹ Ausgrid LED streetlamp trial 2013

³⁰ Energy efficient public lighting – WALGA - 2017

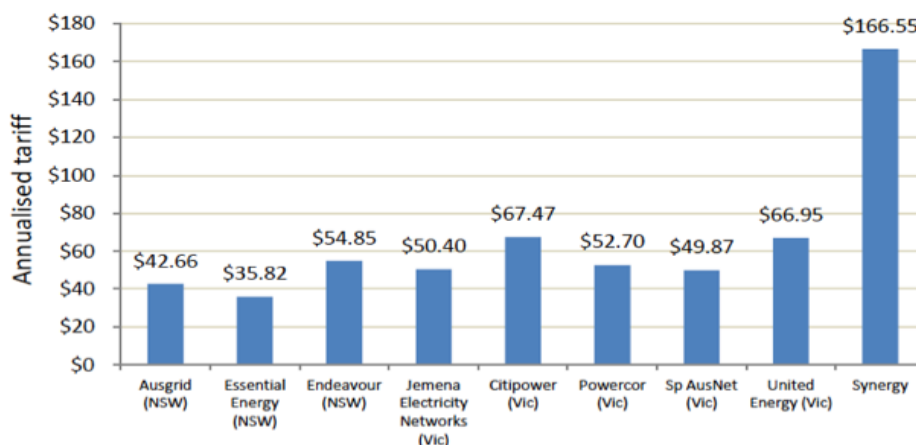
It is true that the regulatory environment needs to change and is changing. Fremantle can assist is lobbying for this change as this would address other issues raised by WALGA including contestability, transparency, road lighting standards, and service standards. Contestability is currently scheduled for 2019 although this has to be clarified with the new government. Our Management actions are premised on the fact that the regulations are in the process of changing and that these steps can be completed in parallel with Western Power now. Western Power has offered to assist with lobbying for a greater competitive environment.

The final point WALGA mentions is about funding. To secure funding a suitable Business Plan with costs and estimated cost savings must be completed. Funding can be secured from a variety of sources. Due to CEFC's mandate, it is perhaps the most appropriate body to start with.

10.6.6 Street light cost comparisons

The below graphs are from the WALGA 2014 energy review, clearly demonstrating that WA local governments pay significantly more for electricity than other Australian States for two of the most common street lights. As WALGA states these costs are caused by the monopoly positions of both Western Power and Synergy and the tariffs are based on an outdated cost recovery model without any transparent breakdown of the cost components. Another explanation could be that Synergy uses streetlight revenues to subsidise other areas of their business. The below diagrams show how Synergy's streetlight costs are significantly higher than elsewhere.

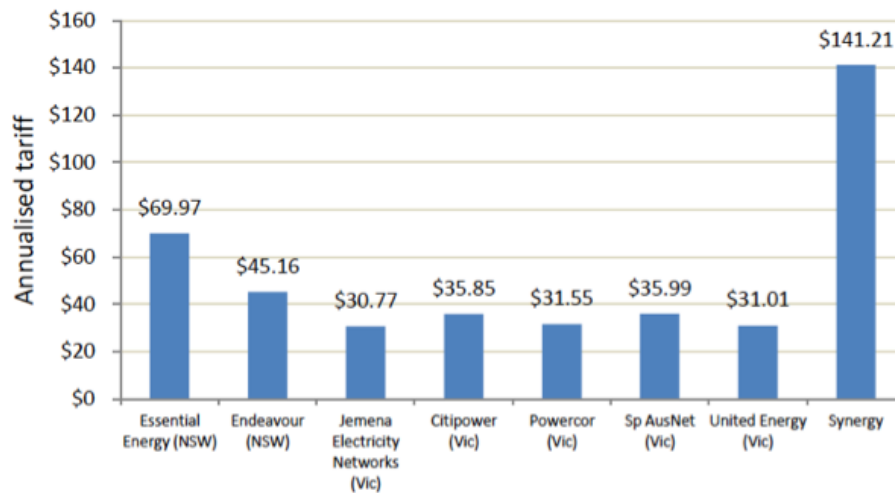
Figure 2.2 Streetlight tariff comparison, 80W Mercury Vapour



Source: Various AER determinations; Synergy price list

Figure 14: Streetlight Cost Comparison by State - MV

Figure 2.3 Streetlight tariff comparison, 42W Compact Fluorescent



Source: Various AER determinations; Synergy price list

Figure 15: Streetlight Cost Comparison by State - CFL

According to the 2017/2018 State budget forecast street light tariffs will have increased 208.2% since 2007/2008³¹. Due to the opaque nature of the costs involved it could be argued a portion of these increases is an indirect tax rather than a cost recovery.

10.6.7 Detail

A summary of the City of Fremantle street lights is contained in the information review section of this report, section 5.4.

(a) Street light replacement program

Western Power will update the catalogue with LED replacements for all types of street and park lighting later in 2017. Currently Western Power’s catalogue currently only provides a 22W LED and this is insufficient for all locations and lighting requirements. The City of Fremantle should work closely with Western Power to ensure these new LED options are adopted sooner rather than later. Once the new LEDs are selected Synergy is required to provide pricing for each type of LED light. These new pricings are expected in early 2018. It should be noted that the existing Synergy price for the LEDs is higher than expected considering comparable information and the reduction in energy and maintenance costs. We have been informed by Synergy that they are unable to split the energy and the maintenance costs due to their accounting system. If LEDs were offered in a competitive environment then it is expected the operating costs would be significantly less than Synergy’s quoted pricing. This is supported by the WALGA analysis of Synergy’s streetlight pricing which also indicates Synergy’s street lighting costs are high and potentially subsidising other areas of their business.

Once the type of LEDs is clarified a cost for the replacement of the traditional lights can be determined.

Following this, the business case for replacing all the streetlights with LEDs can be finalised. This will include the costs of replacement, the operations and maintenance costs. It is highly likely this will produce a positive Net Present Value and a positive investment case.

³¹ WALGA Energy market review 2014

Financing the cost of the replacement program can then be sourced either by the city or by external financing such as the CEFC. The CEFC has already financed similar streetlight replacement programs with the City of Melbourne and the City of Warrnambool in Victoria. The financing costs of the project will be exceeded by the cost savings making this a positive investment decision. If the CEFC are unable to finance this project then there are other Government funds available and this would be commercial viable for the private sector as well.

(b) Streetlight portfolio

Once part of a portfolio there is the option that the City could provide locally generated power to cover the street light energy costs. The repair and maintenance costs would remain with Synergy and Western Power, although Western Power is considering a model where they offer the maintenance of these systems in a commercial agreement, which is expected to be more cost effective in the metropolitan area.

(c) Portfolio contestability

Once street light energy consumption is included in a portfolio, energy supply for the lighting can be offered to the market. Due to regulatory restriction, street lighting is not currently contestable however this is expected to change with the shifting regulation of Western Power to the Australian Energy Regulator and the introduction of full retail contestability. This also allows the City to source green power for these streetlights or potentially use excess power from within the City's future power generation portfolio. Until then LGCs need to be purchased to offset the non-green power supplied by Synergy for street lighting electricity. In 2017 Synergy is mandated to source 14.22% of power from green sources, meaning that 14.22% of grid power from Synergy can be considered to be renewable energy. This means 85.78% of the electricity used for street lighting needs to be covered by the purchase of LGCs to consider this to be renewable energy.

(d) The five stages to changing streetlights

The proposed approach to replacing streetlights is;

- 1) Prepare (develop a business case or financial and technical feasibility analysis)
- 2) Fund (through internal and/or external sources, including financing options)
- 3) Define (develop the Project Plan, Design Plan and Communication Plans)
- 4) Procure (purchase the materials, procure installers and project managers)
- 5) Manage (on-going oversight, liaison with key stakeholders, reporting and ensuring electricity and maintenance savings are flowing through to councils)

(e) Adaptive lighting

Adaptive lighting refers to new technologies that either dim to reduce energy consumption or are variable due to environmental conditions. Dimming and switching can reduce energy consumption but reduce light levels. Dimming may, or may not be viable, depending on local conditions.

Feedback from within the City of Fremantle is that adaptive lighting is expensive and cannot be justified economically at this stage.

10.6.8 Adaptive lighting – pilot project

The feedback from management is that adaptive lighting is currently too expensive to install. Should costs become more competitive then it is recommended that a pilot adaptive lighting project be run to test some of the new technologies in this area. Depending upon the feedback then a project plan for implementing adaptive street lighting could be introduced.

Technology in this area is changing rapidly, for instance solar panels incorporated into the light reducing the need for a dedicated grid connection. These and future options are not available through the Western Power

catalogue at present however should be considered in the future if they become available and if they are commercially a superior option.

10.6.9 Interaction with Other Actions

Lighting services could become part of the energy Portfolio Approach.

Renewable energy certificates may be required to address street lighting energy, and could be procured through the Local Renewable Energy Supply.

10.6.10 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

Using a comparative project, the Warrnambool City Council in Victoria is replacing approximately 2,000 residential street lights with LED technology and is forecast by the CEFC to reduce lighting operation and maintenance costs by 68 per cent.³²³³ If these savings were achieved in Fremantle this would mean cost savings of approximately \$561,373 per year or 26% savings on the City's utility bills. Over the 20-year life of LED lighting this would be an estimated discounted cost savings of \$8.4million.

It should be noted that these cost savings would likely be captured over time as it is dependent upon the type of bulb replaced, the Synergy tariffs, the operating parameters from Western Power and the source of the generation, be that the City of Fremantle or from the grid. The Fremantle Port Authority recently installed LEDs at Victoria Quay and has confirmed significant cost savings. Discussions with GreenBank in the UK also suggested savings on energy and maintenance costs of approximately 60 - 70%. The port has seen savings consistent with this.

Considering comparable projects, a reasonable target for reducing Fremantle's street and park lighting costs would be approximately 50% of the existing energy and maintenance costs. This would equate to \$412,775 in cost savings and the 20-year life of LED lighting this would be an estimated discounted cost savings of \$6.2million.

(b) Assumptions

- It is expected that a program to replace existing street lights with LEDs will be financed, probably through the Clean Energy Finance Corporation.
- The Plan is based on achieving 100% renewable energy and it is intended that Street Lighting energy would be included in the City's Energy Portfolio that will allow netting with green energy sources.

(c) Environmental Analysis

(i) Energy Payback

The payback period will be determined as part of the business case, to be completed.

(ii) Waste and Recycling

LEDs reduce the amount of maintenance and therefore waste and recycling. LEDs lifespans are 4-5 times longer than current lighting technologies, providing a significant environmental advantage.

³² <http://www.cleanenergyfinancecorp.com.au/case-studies/council-saves-on-street-lighting-costs.aspx>

³³ Synergy are unable to split energy and maintenance costs due to their accounting system. This was discussed in depth. Therefore comparable projects are the most appropriate reference point.

(d) Social Analysis

- LED lighting provides a different type of lighting that has been generally viewed as positive elsewhere in the world.
- LED lighting reduces light pollution and can improve direct lighting conditions that can have positive social impacts.

(e) OPL review

Energy efficiency is an objective within the Zero Carbon principle.

10.6.11 Risk Review

LED is a relatively new lighting technology with very specific performance traits. Designers need to be given opportunity to trial these lights prior to a major roll-out.

10.6.12 Program for Implementation

An LED upgrade along Market St is currently underway. Once this is completed the lighting group should be given the opportunity to present the lessons learned internally and use this information to inform a large scale roll-out.

10.6.13 Benchmarks and other measures to be included in reporting

Quantity of lights changed to LED. The lighting mix will be presented annually in the Energy Plan Status Update.

10.6.14 Summary of Management Action

Action	Street and Park Lighting Upgrades
Final Recommendation	1) Trial LED street lights (e.g. current Market St upgrade) and adaptive lighting, and report internally on lessons learned to inform a larger roll-out as more LED options enter the Western Power catalogue in the next year. 2) Once Western Power release their updated catalogue of LED light options, Synergy can finalise their costs. Once this occurs then a complete replacement program of all lights with LEDs is recommended. The costs, payback period and financing can only be completed once the Synergy charges are finalised.
Financial value	Saving \$412,775 per year by 2025, or by the time all lights are changed over
Renewable Energy (kWh/year)	Na (energy saving estimated at 50% street lighting energy, approx. 1,000,000 kWh/year)
Emissions (+/- Tonne CO2e/year)	-820 Tonne CO2e/year
Leadership value	Reduce waste of energy, provide modern lighting system
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓]

Plan Stage to implement	Stage 2
Interaction with other Actions	Lighting services could become part of the energy Portfolio Approach. Renewable energy certificates may be required to address street lighting energy, and could be procured through the Local Renewable Energy Supply.

10.7 Management Action: Voltage Optimisation

10.7.1 Sub-Title of Management Action

Use voltage optimisation suppliers to review City buildings with large electricity loads to test the viability of this technology to save energy.

10.7.2 Summary of Recommendations

- Voltage Optimisation should be considered for the new administration building as part of the base design.
- Providers should be contacted to review other buildings for Voltage Optimisation viability.

10.7.3 Status of Management Action

VO was trialled in the current admin building, and this technology should be investigated for the new building.

Sven De Jonghe, Link Engineering Consultants, and Russell Kingdom, City of Fremantle, have been the main contacts for the new admin building.

VO supplier contacts have been provided later in this section.

10.7.4 Description

The Western Power grid supplies electricity to building at an average of 247 Volts. This is higher than the 220 volts that most electrical equipment is designed for. Western Power's approach is to use a higher voltage, knowing that it will decrease over distance, and with load, to ensure that the supply always exceeds a minimum.

Voltage Optimisation (VO) involves the installation of transformer technology that can bring the voltage supplied to a building to something closer to the nominal supply voltage of 220 volts. This can reduce energy consumption in a number of ways:

- Re-injection of the over-voltage portion can meet some of the load, reducing overall consumption.
- Heating in electric motor windings and some other circuit types is reduced, resulting in energy savings, as well as longer operating life in many cases.
- Resistive loads such as cooking hot-plates and other types of elements, will have a proportionally reduced output, which does not result in a saving if they simply need to operate for longer to do the required job, but the change is rarely noticeable.

VO units typically also provide other power conditioning services such as power factor correction.

10.7.5 Detail

The City invites Voltage Optimisation (VO) system providers to review the energy profile of City assets, and to assess the potential value of VO. Providers are able to install monitoring equipment, given permission, and make their offers based on their own information, which is the preferred approach.

The provider will then make an offer, generally based on a model where they install the system and maintain ownership of it. The City would agree to pay the provider based on the actual savings demonstrated. If savings are not demonstrated, the City does not pay.

This low risk arrangement has evolved because of the limited understanding of VO amongst both building managers and engineers, and a resulting resistance to the technology.

As a rule of thumb, buildings that consume more than 300,000 kWh/year (>\$35K per year) are likely to be viable for VO. Other factors include the age and replacement cycle of existing transformer equipment, space and access constraints, load types in the building, and the value of power conditioning.

10.7.6 Process Notes

To proceed this Management Action, the City needs to engage directly with providers and agree on a pathway that will result in an offer being made for a performance contract that contain minimal risk for the City. There are a number of providers that could be contacted, for example:

Powerstar (part of EMSc (UK) Ltd Asia Pacific)

A: Suite 205, 17-33 Milton Parade, Malvern VIC 3144

T: 03 9832 0693 / 0411 720 760 (Sam Czyczelis)

E: sam.c@emscap.com.au

W: <http://powerstar.com/au/>

Energywise

A: Level 14, 70 Pitt St, Sydney 2000 NSW Australia

T: 1300 843 275

E: info@energywise.net.au

W: <http://energywise.net.au/voltage-optimisation/>

Rexel Energy

A: Unit 46, 317-321 Woodpark Road Smithfield NSW 2164

T: 1300 32 66 32

E: info@rexelenergy.com.au

W: <http://www.rexelenergy.com.au/contact>

10.7.7 Interaction with Other Actions

Energy Plan Annual Reports: include any actions/recommendations around VO.

10.7.8 Triple Bottom Line and One Planet Living (OPL) Analysis

(a) Financial Analysis

This Management Action would only proceed as a revenue positive proposal from a provider, with minimal risk to the City.

(b) Environmental Analysis

(i) Emissions Impacts

Analysis by the provider will give a modelled prediction of energy and emissions reductions. Generally, a VO project will not proceed unless 10% or better energy savings are predicted.

(ii) Materials, Waste and Recycling

The overall materials footprint of the equipment in question is small, given its longevity. Transformers require occasional replacement, so this is a good opportunity to introduce a VO solution.

(c) Social Analysis

The equipment to implement VO is generally hidden in a plant room and won't have a great impact on the public – positive or negative. However, adopting this poorly understood technology in Fremantle buildings would show industry leadership in building design and management, and potentially unlock large savings for other Cities by making a case study available.

(d) OPL review

This is primarily a demand-side energy saving initiative that will contribute to the Zero Carbon principle.

10.7.9 Risk Review

Risk	Possible Impact	Likelihood	Response
Staff resistance to alternative technologies	Tendency to blame the VO unit for problems that have no easy explanation (e.g. lamp life less than expected)	Low to moderate	Provider to be required to respond to any issues that could relate to the unit for a period of minimum two years from installation.

10.7.10 Program for Implementation

Contact should be made with VO providers as soon as possible to begin the conversation around the new administration building and other large load City buildings.

NOTE: VO should be considered for the **new administration building** as part of the base design.

10.7.11 Benchmarks and other measures to be included in reporting

- Once installed, the continued operation of VO units should be reported on.
- Energy savings due to VO will be difficult to distinguish from other causes, so the agreement with the provider should include a mechanism for demonstrating the savings in a clear and measurable way (e.g. a safe method for disconnecting and reconnecting the voltage management and measuring the comparison).

10.7.12 Summary of Management Action

Action	Voltage Optimisation
Final Recommendation	VO should be considered for the new administration building as part of the base design. Providers should be contacted to review other buildings for VO viability.
NPV / LCoE	Revenue positive at all times.
Renewable Energy (kWh/year)	Minimum 30,000 kWh per building
Emissions (+/- Tonne CO2e/year)	-25 Tonne CO2e/year
Leadership value	To asset managers and building engineers
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓]
Plan Stage to implement	Stage 3, and whenever a building transformer requires replacement
Interaction with other Actions	•Building energy audits should include a pre-assessment regarding the total load and the state of the current building transformer.

10.8 Management Action: City Owned Photovoltaic Systems

10.8.1 Subtitle of Management Action

Install Maximum Size Photovoltaic (PV) Systems on City Buildings

10.8.2 Summary of Recommendations

- 1) Install solar PV systems on City buildings subject to:
 - A quote from a reputable supplier that includes the retirement of Renewable Energy Certificates (see explanation in this section), a review of the building roof and electrical system ability to support the solar system, a communication link to City data capture system, and all approvals required.
 - The City’s budget position or financing package provided by supplier.
 - Comparing the levelized cost of energy for rooftop PV systems to whatever power supply arrangement the City arrives at on the basis of this Plan.
 - The expectation that the building will remain under City ownership in the long term.

- The metering arrangement at the building is favourable, or can be revised (see advice in this section).
- 2) Install PV systems on non-City roof tops subject to:
- A portfolio approach being enabled for City electricity account, which has a mechanism for adding additional elements such as the additional PV systems being proposed.
 - A survey of potential roof top sites being conducted, and in-principle agreements with the relevant owners being in place [may require some consultant input].
 - The caveats applied to PV systems on City buildings above.

10.8.3 Status of Management Action

This Management Action should be implemented after a green energy supply has been negotiated. The levelised cost of PV rooftop generated energy, provided in this section, can then be compared to the tariff that is negotiated. The added management load and complexity of owning a system, versus simply paying for energy, should be considered also.

Local PV suppliers that contributed to this report include:

- 1) SolarLuna (Gabor Bencze, System Designer, gabor@solarluna.com.au)
- 2) Infinite Energy (Duan Pater, Commercial Consultant, duan@infiniteenergy.com.au)

10.8.4 Description

Proposed PV systems for City building rooftops. The methodology has been to estimate the roof area available from aerial imaging, allowing for any shading impacts, and to calculate the largest feasible PV system size for that roof. Where there are existing PV systems at the site, a recommendation is made on either adding to the existing system, or replacing it.

These sites are then sent to commercial providers for detailed sizing and indicative quotations. Given the role out of this Plan over a number of budget cycles, and the current continuing trend for PV cost to continue to reduce, a standard procurement process, using the indicative quotes as guidelines, is recommended.

For the purposes of this Plan, the City has identified a subset of City buildings that are to be considered. Where opportunities to install systems on other City assets have been identified, these are listed also with a note that they are not in the provided scope.

Other approaches to PV exist (e.g. built-in façade PV) but these are not well established in WA and come with a cost penalty, and so are not considered at this stage. These more exotic systems could be suitable for new builds, such as the new administration building, or the depot.

10.8.5 Detail

The potential for rooftop PV systems on City buildings has been estimated using aerial images and modelling software. The baseline estimation was performed by Fremantle based renewable energy provider, Solarluna. The following table presents existing and potential new PV rooftop systems on buildings identified by the City as being within the scope of this Plan. The fundamentals that underpin the estimates can be applied to other sites if identified, although with the common caveat that these are today's figures and can be expected to

change. The retiring or cashing-in of Renewable Energy Certificates (RECs) has a large impact on capital cost, and is explained in the financial section.

Table 12: Cat1 buildings, PV sizing, deemed production, and cost

Name	Existing System size (kWp)	Additional PV system Size (kWp) MAX	Predicted Annual Energy (kWh/year) All systems	Annual Energy Consumed (kWh/year FYE2016)	Indicative new PV System Cost (\$)	Indicative new PV System Cost - RECs retired (\$)	Estimated payback period (years)
Site name as provided	As provided	Estimated size possible	Notional total production	Total consumption FYE2016	RECs cashed in for capex savings	Maintain 'green' value by retiring RECs rather than cashing in.	Simple Payback (RECs retired)
Fremantle Arts Centre	-	22	26,000	246,875	\$30,450	\$47,283	9
Civic Admin Building	10	75	108,820	837,686	\$105,560	\$163,914	7
The Meeting Place	2	20	27,764	7,528	\$28,420	\$44,131	8
Knutsford St Depot	-	174	240,000	117,200	\$295,800	\$430,462	13
Samson Recreation Centre	-	83	110,000	49,441	\$115,710	\$179,674	12
Moore's Building	-	16	20,000	80,995	\$20,735	\$33,079	8
Fremantle Town Hall	10	0	13,820	?	na	na	na
Fremantle Leisure Centre	30	0	41,460	2,354,695	na	na	na

Name	Existing System size (kWp)	Additional PV system Size (kWp) MAX	Predicted Annual Energy (kWh/year) All systems	Annual Energy Consumed (kWh/year FYE2016)	Indicative new PV System Cost (\$)	Indicative new PV System Cost - RECs retired (\$)	Estimated payback period (years)
Fremantle Hockey Club	-	51	70,000	47,417	\$71,050	\$110,326	9
Ken Allen Reserve	-	51	75,000	72,224	\$71,050	\$110,326	7
Totals	52	492	732,864	3,814,061	\$738,775	\$1,119,195	

10.8.6 Process Notes

A review of structural and electrical infrastructure at each site must be part of the system design process, with any issues noted in the annual *Energy Plan Status Update*.

(a) Metering and City PV systems on Tenanted Buildings

PV systems on City assets that have a utility meter and associated electricity account generally do not need any change to the metering arrangements other than upgrading to a Western Power 'Smart Meter' as per the grid connected PV system regulations.

There is some mythology around the complexity of adding PV to buildings that are tenanted. City owned buildings that are wholly or partially tenanted can also support PV systems that would contribute to meeting a 100% renewable energy target (if the building is included in the portfolio of energy accounts that are being considered in the Corporate Energy Plan).

Consider the situation of buildings where there are one or more tenants occupying a building that is owned by the City. In this case, the benefit of low cost, or free, electricity from a PV system is expected to benefit the tenants but, in fact, this situation can be an opportunity for the building owner: The City. There are four general metering arrangements that apply:

- 1) The tenants pay a fixed energy cost, regardless of consumption. In this case the financial benefit of PV energy used on site flows to the City. It is recommended that sub metering should be installed, generally, so that there is a price signal to the energy user.
- 2) Tenants pay pro-rata based on floor area occupied. In this case PV energy used on site will reduce the overall cost and the benefit flows to the tenants. The City should install sub metering so that the value of PV can be captured. With sub metering the City is in a position to offer a fair tariff to tenants, whilst reducing its own costs. The PV system must be connected behind the main utility meter, in front of the sub metering network.

- 3) Tenants are sub metered. As above, the PV system must be connected behind the main utility meter, in front of the sub metering network.
- 4) Tenants have their own Western Power meter and their own energy account with a retailer. In this case the City will pay only for common area and common services energy, resulting in a small load. A large PV system will create excess to be exported, which should be captured or shared with other City sites.

In all cases, excess electricity can be shared or stored in City systems depending on what other systems have been put in place. Where sub metering has not been installed, it is recommended that it should be so that a price signal is provided to tenants to encourage energy efficiency.

(b) Assumptions

- Where larger systems are proposed, Western Power approvals may be more complex. This process must be included in supply and costed by the supplier.
- Electricity production from PV systems is calculated at the Federal Government's deemed rate of 1,382 kilowatt-hours per kilowatt-peak installed for this zone. This is a conservative figure in most cases, with optimally installed systems in Fremantle typically producing 1500-1600kWh/year.

10.8.7 Interaction with Other Actions

The following Management Actions that are recommended in this Plan may impact this Management Action:

- Energy Plan Status Updates: PV system roll-out plan to be tracked
- Data reform: PV data collection to be standardised and performance benchmarked
- Local PV systems, Offset Strategy: The scale of other Actions is dependent on the scale of renewable energy systems installed by the City.
- Contestability: Many City sites are below the current Contestability Threshold, and so cannot freely choose electricity retailer – they must connect through a Synergy account. The contestability threshold regulation is defined around the level of consumption. A nett production site may not be covered, and may be contestable by default. This is a backup argument if there are delays in achieving contestability for the City's electricity portfolio by other means, and would rely on nett production being achieved at smaller load sites, generally by the installation of PV systems.

10.8.8 Triple Bottom Line and One Planet Living (OPL) Analysis

(a) Financial Analysis

The following figures emerged from analysis of this management action, and can assist with assessing other PV system opportunities that may arise.

PV installed system cost in 2017:

Indicative new PV System Cost (\$) [RECs cashed]	Indicative new PV System Cost (\$) [RECs retired]
\$1.20-\$1.80/watt	\$1.97 - \$2.57 /watt
Indicative only - will be formally procured. Prices vary on complexity and approvals.	Maintain 'green' value by retiring RECs rather than cashing in.

Levelized cost of energy (LCoE) here is an indicative cost per unit (kWh) of electricity over the warranted lifetime of a PV system if it is bought outright.

At the market prices indicated above:

- LCoE if RECs are retired: \$0.14 / kWh
- LCoE if RECs are cashed in: \$0.11 / kWh

According to the Australian Energy Council Solar report December 2016, the cost of energy produced from rooftop solar PV is 10 cents per unit for a 5KW installation, which is in line with the above calculated result when RECs are cashed in and some real-world contingency is allowed (see Assumption section below).

(i) Understanding RECs

The national Mandatory Renewable Energy Target (MRET) created a market place with a tradeable currency – the Renewable Energy Certificate (REC). This is a slightly arcane topic but impacts decision making in this Plan, and so requires some explanation. RECs represent the ‘renewable’ aspect of renewable energy generation, but not the energy itself. When an entity that is required to meet the MRET in their energy portfolio, they may buy RECs, or generate RECs through their own generation projects, which they then ‘retire’ (have removed from the market permanently) to meet their obligations. Smaller renewable energy systems create “Small-scale Technology Certificates” (STCs), whilst larger ones (e.g. over 100kWp PV) produce “Large-scale Generation Certificates” (LGCs)³⁴. These certificates are created for every 1-megawatt-hour of energy generated by a registered renewable energy system.

In the domestic context, PV system owners generally cash in the renewable energy certificates for which their system would be eligible under the national MRET framework. Cashing in RECs reduces the capital outlay significantly as the Federal Government deems the first fourteen years of production and pays the value up front. Until 2017, fifteen years of production was deemed. The figure will reduce annually until 2030 when the scheme is terminated.

When RECs are cashed-in, they become available on the REC market. This means that a buyer can purchase the certificate and claim the ‘renewable’ aspect to ‘offset’ 1-megawatt-hour of non-renewably generated energy that they have consumed. Hence the original 1-megawatt-hour of energy that was generated takes on the emissions profile and quality of the 1-megawatt-hour of energy that the buyer is offsetting.

In short, the City of Fremantle cannot use rooftop PV systems to help meet its 100% Renewable Energy target unless any RECs generated are retired.

(ii) Payback times

PV payback times are dependent on the capital cost, the performance of the system, the tariffs for consumption versus export, and the split between day/night consumption. For example, office buildings tend

³⁴ For further information see: <https://www.rec-registry.gov.au/rec-registry/app/public/what-is-a-rec>

to use more energy during the day, with a summer peak in the mid-afternoon. Those that export an amount of the PV production have longer payback times on the assumption that the City would receive the typical 8 cents per unit for this energy. The Portfolio Approach with 'netting-off' would improve the economic performance of these larger systems.

(iii) Assumptions

The figures above hinge on a number of assumptions:

- The LCoE is sensitive to;
 - Production rate, which slows over PV system life, assumed an average 90% over lifetime.
 - Total system cost, which may include the Renewable Energy Certificate (REC) value (currently \$40/MWh, deemed at 1.382 MWh/kWp, paid upfront for the first 14 years of production – reducing each year over the next 13 years to 2030).
 - Warrantee period, assumed to be 25 years with 80% performance.
 - Component lifespan, assumed to be 10 years for inverters, estimated at 30% of original system cost each time.
 - A 20% loading has been added to capital cost estimates to consider real-world contingency and City officer time.
- Figures are presented assuming firstly that the City would retire STCs (the type of REC produced by small systems – under 100kW of PV), thereby capturing the 'green' value of the electricity produced, represented by removing it from the MRET market pool, thereby implicitly requiring more renewable generation to be brought online to meet total national obligations under the scheme. RECs are typically cashed in at purchase to reduce capital cost, and become available to parties that are obliged to retire a certain number of certificates representing renewable energy under the MRET scheme each year.
- Finally, the following assumptions also include an element of risk to enable fair comparison to, for example, an alternative, central system, or a grid solution for supply, where commercial risk is taken by the supplier. This risk profile is represented by a simple 20% loading on the capital cost in all cases.
- Maintenance and performance auditing is estimated at 5 hours per system per year, charged at \$100/hr
- Systems will be installed when the City budget allows, therefore financing analysis is not based on debt.

(b) Environmental Analysis

(i) Energy Payback

PV systems have suffered from a perception that they require more energy and emissions to create than they offset in their lifetime. This notion has been debunked in recent times, with estimated 'energy payback' being

around 3 years for typical PV systems, including the modules. The following chart, from Dr Muriel Watt, UNSW, provides a summary of a number of studies of mainstream PV systems:

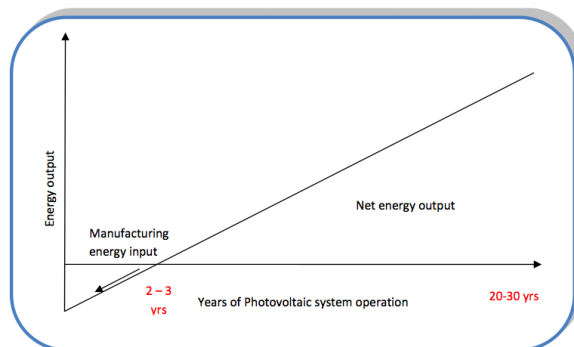


Figure 16: PV system energy payback chart³⁵

(ii) Waste and Recycling

PV modules and other components include some exotic metals, sometimes including heavy metals such as cadmium and lead, generally in trace amounts. There is a vast amount of waste PV material globally, with Australia's PV waste stream growing slowly. The recommended response is aligned to the classical waste materials hierarchy:

1. Reduce: the PV module is generally very long-lived, with modules producing useful amounts of power after 50 years or more, so they are inherently providing long term value for the material consumed. The key aspect of reducing PV module use is to reduce energy consumption through behaviour change, and through efficient design of our energy consuming systems and built form.
2. Reuse: Finding opportunities to re-deploy modules and systems can be difficult but the off-grid market can provide an opportunity where changing standards may prevent new on-grid options for an older system. A second-hand market exists in this space.
3. Recycle: recyclers who can manage PV modules are in a growth industry. One example, that looks to reclaim good condition individual cells from salvage modules is: <http://reclaimpv.com/#about>

(c) Social Analysis

- Reducing greenhouse gas emissions is a social imperative for preserving human systems.
- Distributed generation improves resilience by reducing the load on the electricity network and enabling robust local systems. Embedded generation will eventually enable a grid that will be largely self-healing, and certainly able to remain functional in parts when others are off line.
- There is an established phenomenon whereby people who can visually identify the green energy source that is powering their building or neighbourhood are more engaged in energy management.
- If the City can develop a core competence around procurement, management and operation of renewable energy installations, then the possibility of creating a community solar or wind scheme that can make renewable energy more accessible to Fremantle residents is created.

³⁵ <http://reneweconomy.com.au/graph-of-the-day-myth-of-solar-pv-energy-payback-time-22167/>

(d) OPL review

The move to a 100% renewable energy supply is a core objective of OPL.

10.8.9 Risk Review

Causal Factor	Resulting risk	Possible Impact	Likelihood	Response
Visual/heritage impact	Complaints from neighbours or other stakeholders.	Requested removal of system	Medium	Inspect proposed sites from the ground prior to committing to project.
PV Installation is not compliant with Australian Standard or Western Power requirements	Non-completion/conn- ection of system.	System may not be functional until problem rectified.	Medium	Contract to adequately cover scope of works. "All approvals required for intended operation" to be clearly specified
OH&S practices not adhered to	Injury to Contractor or site users during implementation of works	Loss of project momentum, loss of staff and loss of staff income	Medium	Ensure normal City OH&S procedures apply.
Work not completed to schedule	Project stalls/loses momentum	Generally limited – some loss of production.	Medium	Any dependent project elements to remain informed.
Contractors not fully aware of specification requirements	Contractors do not deliver works as specified	Poor quality installations that do not meet standards or site-specific requirements	Medium	Professionally reviewed specification and selection of well-reviewed supplier.
Network structural issues preventing the PV systems from being connected to the grid	Leads to abandonment of the project or delays in construction	Connection Application submitted to Western Power would be rejected	Medium	Adopt portfolio pre-approval of all proposed systems.
Installation creates/increases water penetration issues at the buildings level.	Careless installation of PV system causing penetration issues	Possible water ingress in buildings leading to damage or flooding. Need for repairs.	High	Risk to be identified and clearly scoped into the installer's responsibilities.
Structural roof issues unforeseen at the design level	Installation is delayed due to building roof issues	Delays or expense in the installation	Medium	These issues to be reviewed by installer and acknowledged as their risk within reason.

Causal Factor	Resulting risk	Possible Impact	Likelihood	Response
Equipment currently positioned on the selected building roofs impeding the straightforward installation of the PV system	Relocation needs not established during project design	Delays in the installation	Medium	These issues to be reviewed by the installer and acknowledged as their risk within reason.
Installation costs have been underestimated.	Change in market price could lead to higher investment costs and therefore limit the implementation of the first round	Additional cost, leading to reduced overall scale of installations.	Low	Priorities have been identified, costs are quoted in advance by suppliers.
Installed equipment or infrastructure underperforms	Installation does not achieve the expected performance.	Reduced production and income.	Medium	Supplier to provide predicted performance, reviewed by competent engineer

10.8.10 Program for Implementation

This is a Stage 2 Management Action, with hold points depending on some other Management Actions being implemented, or not.

- Hold #1: If the portfolio approach recommended elsewhere has been implemented, then all accounts will be contestable through the portfolio, and rooftop PV systems may not be financially competitive with the chosen large scale renewable energy supplier.
- Hold #2: Negotiate the recommended large scale renewable energy supply initiative prior to commencing with rooftop PV as this may outperform rooftop PV financially, and may be available to many, or all City accounts.
- Partial go #1: If the portfolio approach is not implemented, then preference systems on non-contestable account buildings as the contestable buildings will be very likely supplied by a local, larger scale renewable energy supplier as discussed elsewhere in this Plan. Have an updated specification created by an experienced renewable energy engineering firm to ensure that a robust system, with an equally robust communications system, is installed.
- Hold #3: Once/If a suitable rooftop system is identified, have the roof and electrical installation reviewed by the preferred supplier prior to committing to the system and ensure that they will own any reasonable risk that they should foresee.

10.8.11 Benchmarks and other measures to be included in reporting

- Deemed production rate: 1,382 kWh/kWp/year.
- Emissions Offset: a method for assessing the carbon reduction offset of PV production. PV generated electricity exported to the grid is often understood to have a net emissions reduction when the eventual consumer avoids importing grid electricity. However, if the system attracts renewable energy credits that are then sold to reduce the capital outlay, production from the system up to the value of the credits sold cannot be claimed in calculations of emissions reduction.
- Data: continuously available. Assume a one-hour maintenance shutdown of inverter per year.

10.8.12 Summary of Management Action

Action	City Owned Photovoltaic Systems
Final Recommendation	Rooftop PV will not supply the majority of the City's electricity load. The financial value of rooftop PV must be assessed in the context of the solution that is negotiated to meet the majority of the City's load.
NPV / LCoE	14 cents/kWh (100% renewable energy)
Renewable Energy (kWh/year)	733,000 kWh
Emissions (+/- Tonne CO2e/year)	-600 Tonne CO2e/year
Leadership value	Systems will be visible around the City
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓] Sustainable Materials and Zero Waste [x]
Plan Stage to implement	Stage 2
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: PV system roll-out plan to be tracked •Data reform: PV data collection to be standardised and performance benchmarked •Local PV systems, Offset Strategy: The scale of other Actions is dependent on the scale of renewable energy systems installed by the City.

10.9 Management Action: Local Renewable Energy Supply

10.9.1 Sub-Title of Management Action

Local renewable energy supply

10.9.2 Summary of Recommendations

- 3) Identify shortfall in renewable generation required by the City of Fremantle
- 4) Prepare an Expression of Interest for renewable energy and the terms available to source this required renewable generation
- 5) Compare the net project costs (over the project life) to other alternatives for renewable energy available such as solar PV in a portfolio approach over the City of Fremantle Buildings, GreenPower Connect options, other retailer proposals and specific renewable energy projects such as South Fremantle Solar Farm or Port wind projects.
- 6) Whichever provides the best terms and lowest costs should be adopted and contracts entered into.

10.9.3 Status of Management Action

It is understood that an offer has been made to the City by the South Fremantle Solar Farm developer, but that Synergy requires another PPA customer before they can proceed. City of Stirling was cited as a potential second customer for the solar farm. An offer for a 'green power connect' supply agreement has been procured from Alinta, and will be provided separately to the City as a means of comparing the solar farm offer. Should this be of interest to the City then the city of Fremantle should send the power demand profile to Alinta so that they can finalise the network delivery charges (at cost).

Louise Ainsworth, Senior Strategic Projects Officer, City of Fremantle has been the main City contact for this management action.

10.9.4 Description

The City of Fremantle wishes to procure 100% renewable energy. There are a variety of identified options available however there is likely other options in the market that have not been identified. Although an existing option is to install solar PV on as many buildings in Fremantle there may be cheaper and better solutions. A standard approach is an Expression of Interest process to identify potential unidentified solutions. Once all options are available, the capital and operating costs can be considered together with the terms and risk profile. Management must evaluate these options and select the project or projects with the most suitable risk and reward profile.

10.9.5 Detail

City as anchor customer for a renewable energy project, for example:

(a) South Fremantle Solar Farm

The potential South Fremantle Solar Farm project depends upon the terms and pricing offered by the project developers. These terms would need to be considered together with other renewable energy options currently available.

(b) Solar PV Fremantle Port Authority

The Fremantle Port Authority has the existing option to develop up to 750KW of solar PV at Victoria Quay. The Fremantle Port Authority has indicated a price equal to the Synergy R3 high voltage tariff that is lower than the current low voltage tariff the City pays. This power could be included in the local microgrid and used to reduce electricity costs, increase renewable energy consumption and reduce carbon emissions throughout the City.

(c) Alinta

Alinta has provided a proposal to supply 100% renewable energy under the GreenPower Connect program.

10.9.6 Process Notes

To proceed with this Management Action, the City needs to prepare an Expression of Interest for the amount of renewable energy required. In particular the following companies should be invited to respond.

EMC, Zenith Energy, Balance Group, Reposit, RedBack Energy, Sonnen and others have been identified.

The responses need to be considered together with other local options such as the South Fremantle Solar Farm project, wind projects, Fremantle Port Authority power etc.

10.9.7 Interaction with Other Actions

The source of the renewable energy needs to be incorporated into the portfolio, or microgrid or virtual power plant.

10.9.8 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

This Management Action would only proceed if there is a reduction in costs or other economic benefits to the City of Fremantle.

(b) Environmental Analysis

(i) Emissions Impacts

The proposal is for projects that are 100% renewable energy, replacing an energy supply that has been carbon neutral through use of offsets, so there is no nett impact on emissions.

(ii) Materials, Waste and Recycling

Terms to be included in the EOI process to ensure that low embodied energy modules are selected, and that a salvage/recycling plan is in place for end-of-life.

(c) Social Analysis

It is expected that this project will demonstrate industry leadership in this sector.

(d) OPL review

This is primarily a demand-side energy saving initiative that will contribute to the Zero Carbon principle.

10.9.9 Risk Review

Risk	Possible Impact	Likelihood	Response
The EOI process should detail the risks of the project	As defined in the EOI process.	As defined in the EOI process.	Dependent upon the EOI process.

10.9.10 Program for Implementation

This is a Stage 1 Management Action, with hold points with other management actions depending on this one being implemented, or not.

10.9.11 Benchmarks and other measures to be included in reporting

- 100% renewable energy supplied for all electrical loads.

10.9.12 Summary of Management Action

Action	Local Renewable Energy Supply
Final Recommendation	Obtain a range of quotes from green energy suppliers to set price benchmarks, including: Greenpower from Synergy, Greenpower Connect from Alinta. Negotiate a supply arrangement with a local green energy project that can be enabled by the City's account.
Financial analysis	It is expected that green energy can be found for the same price as is currently being paid for black power plus offsetting.
Renewable Energy (kWh/year)	2,100,000 kWh
Emissions (+/- Tonne CO2e/year)	-1,720 Tonne CO2e/year
Leadership value	Enabling a renewable energy project, achieving target.
OPL impacts	Zero Carbon (100% renewable energy) [✓ ✓ ✓]
Plan Stage to implement	Stage 1
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: Green energy use to be tracked •City PV Systems: The amount of green energy purchased is dependent on the scale of renewable energy systems installed by the City.

10.10 Management Action: Gas Accounts

10.10.1 Sub-Title of Management Action

Gas consumption

10.10.2 Summary of Recommendations

Review the gas accounts. If the accounts are no longer needed then disconnect and save money on connection fees.

10.10.3 Status of Management Action

The table of gas accounts has been provided to the City. It is understood that there may have been a change to the naming convention and that has caused delays in reviewing these accounts to establish if they are still required.

Paul Skipworth, Senior Finance Officer – Budgeting, City of Fremantle, has been the main City contact for this management action.

10.10.4 Description

During the review a suite of gas accounts with no usage were identified. A list of these gas accounts (see table below) was submitted to management for investigation.

Figure 17: City of Fremantle gas accounts that may not be required.

Location	Contract number	Greensense	Comment
245 South Tce	Alinta Gas Purch - 262489470	Zero usage	Is this a measurement issue or is the connection unnecessary?
8 Harvest Road	Alinta Gas Purch - 386347310	Zero usage	Is this a measurement issue or is the connection unnecessary?
Arthur Head Cottages	Alinta Gas Purch - 311001365	Zero usage	Is this a measurement issue or is the connection unnecessary?
Arthur Head Cottages	Alinta Gas Purch - 500000919	Zero usage	Is this a measurement issue or is the connection unnecessary?
Arthur Head Cottages	Alinta Gas Purch - 920001501	Zero usage	Is this a measurement issue or is the connection unnecessary?
Bruce Lee Reserve	Alinta Gas Purch - 584350750	Zero usage	Is this a measurement issue or is the connection unnecessary?
Cricket And Hockey Club	Alinta Gas Purch - 506997459	Zero usage	Is this a measurement issue or is the connection unnecessary?
Dental Clinic	Alinta Gas Purch - 858009150	Zero usage	Is this a measurement issue or is the connection unnecessary?
Hilton Community Centre	Alinta Gas Purch - 658000533	Zero usage	Is this a measurement issue or is the connection unnecessary?
Lot 10 Newman Court	Alinta Gas Purch - 988561550	Zero usage	Is this a measurement issue or is the connection unnecessary?
Rugby Club	Alinta Gas Purch - 515230190	Zero usage	Is this a measurement issue or is the connection unnecessary?
Stan Reilly Lodge	Alinta Gas Purch - 160001743	Zero usage	Is this a measurement issue or is the connection unnecessary?
Valley Park	Alinta Gas Purch - 710322670	Zero usage	Is this a measurement issue or is the connection unnecessary?
Valley Park	Alinta Gas Purch - 843998641	Zero usage	Is this a measurement issue or is the connection unnecessary?

If these gas accounts are no longer required then the connection should be disconnected to save costs.

10.10.5 Process Notes

Review the accounts to determine whether or not these accounts are still active. If they are active, is there any gas usage. If there is no gas usage and unlikely to be future gas usage then inform Alinta of the account and disconnect the gas connection until required.

10.10.6 Interaction with Other Actions

None.

10.10.7 Triple Bottom Line and One Planet Living (OPL) Analysis

For the purposes of this Plan, the 'value' of each Management Action is assessed against triple bottom line and One Planet Living (OPL) impacts.

(a) Financial Analysis

Savings on unnecessary account charges where the gas connection is not required.

(b) Environmental Analysis

(i) Emissions Impacts

N/A

(ii) Materials, Waste and Recycling

N/A

(c) Social Analysis

N/A

(d) OPL review

N/A

10.10.8 Risk Review

Risk	Possible Impact	Likelihood	Response
Ensure that the gas connections are not required	Disconnection of gas that is required which will cost additional money to reconnect.	Minimal	Management action.

10.10.9 Program for Implementation

This is a Stage 1 Management Action, with no reason to delay.

10.10.10 Benchmarks and other measures to be included in reporting

- Accounts closed and fixed charges saved should be reported in the Energy Plan Status Update.

10.10.11 Summary of Management Action

Action	Gas Accounts
Final Recommendation	Review the gas accounts. If the accounts are no longer needed then disconnect and save money on connection fees.

Financial analysis	Savings on unnecessary account charges where the gas connection is not required.
Renewable Energy (kWh/year)	na
Emissions (+/- Tonne CO2e/year)	na
Leadership value	Fiscal management.
OPL impacts	na
Plan Stage to implement	Stage 1
Interaction with other Actions	•Energy Plan Status Updates: report on closing of accounts and fixed charges saved.

10.11 Management Action: Sustainable Corporate Transport

10.11.1 Sub-Title of Management Action

Move to Low Emissions City Fleet Vehicles and Encourage Alternative Transport Options

10.11.2 Summary of Recommendations

Request officers to test viability of options to meet the 2020 OPL Corporate Transport Target of 30% emissions reduction and adopt the Climate Change Authority’s 2025 emissions target as a fleet average.³⁶

The key elements of this Management Action are:

1. Incentivise alternative transport choices.
- 7) Set targets for fleet emissions intensity.
- 8) Create a regular reporting schedule so that progress towards the target can be tracked.
- 9) Enable electric vehicles through charging points and carpark design.
- 10) Identify vehicle types that are suitable to be procured as electric vehicles over the coming years.
- 11) Identify opportunities to reduce vehicle size
- 12) Enable route efficiency
- 13) Consider bio-fuels, particularly bio-diesel for heavier vehicles.
- 14) Identify opportunities to incentivise lower emission choices through the novated lease / salary sacrifice system.

³⁶ CCA targets standard: <http://www.climatechangeauthority.gov.au/reviews/light-vehicle-emissions-standards-australia>

10.11.3 Status of Management Action

Understanding the City's fuel consumption is important to beginning to manage it, and the resultant emissions. Currently, there appears to be little in the way of coherent data.

Some alternative transport option incentives have already been trialled by the City. These may need reviving. A bulk buy of electric bikes could be considered if enough staff are interested – the RAC recently negotiated excellent prices from suppliers.

Efficient options are already being implemented - the proposed target should give this tendency some impetus.

Gordon Davis, City of Fremantle, has been the main City contact for this management action.

10.11.4 Detail

(a) Set targets for fleet emissions intensity.

Cars account for 10% of Australian greenhouse gas emissions and most toxic air pollution in cities. Some selected benchmarks for operational CO2 emissions are:

- Internal Combustion Engine (ICE) (AU car average): 192 gCO2e/km
- 2015 Corolla: 153 gCO2e/km
- Battery Electric Vehicle (BEV) WA Grid: 144 gCO2e/km
- Climate Change Authority 2025 Target: 105 gCO2e/km
- BEV on Green Power: 0 gCO2e/km

It is recommended that the City seek to achieve the Climate Change Authority 2025 Target across the City light vehicle fleet, including passenger vehicles and light utility vehicles (utes).

(b) Incentivise alternative transport choices

The Department of Transport's 'Your Move' program supports switching more trips from the car to active modes (walking, cycling, public transport). This includes support for workplaces wanting to encourage active travel by their staff – through the website www.yourmove.org.au The City of Fremantle has registered for the 'Your Move' website. Any workplace initiatives can be shared with the network of workplace champions through this website.

The City could support staff public transport use by:

- Making SmartRider cards available for business trips (for destinations readily accessible by bus, train)³⁷. These are available now.
- Providing trial SmartRider cards and credit for staff who drive to work but are willing to trial public transport commuting.
- Subsidising staff commuting by public transport, e.g. by adding value to staff SmartRider cards or offering a staff travel allowance – see footnote for the website. A version of this was tried previously as an option for people handing back their parking rights.

The City is already giving access to bicycles for staff on City business. The City could support staff use of bicycles by:

- Allowing use of pool bicycles for trial cycle commutes

³⁷ <https://yourmove.org.au/resources/provide-office-smartriders-for-business-trips/>

- Enabling salary sacrificing of electric bicycles ³⁸
- Using peer support (e.g. buddying up novice and experience cyclists for initial rides to work), cycle skills training and workplace events to promote cycling – see footnote for the website.

Providing subsidies or equipment for commute trips may constitute a fringe benefit for taxation purposes so it would be worth seeking advice on financial implications if these measures were to be considered.

(c) Create a regular reporting schedule

The annual energy report should include a short section on fleet fuel and emissions, including at minimum:

Vehicle type	Fuel	Total travel (km)	Total Fuel consumed (kL)	Emissions factor (kg CO2e / L)	Total emissions (kg CO2e)	Intensity (gCO2e/km)	Intensity (gCO2e/km) PREVIOUS YEAR
Light passenger	ULP			2.32			
Light passenger	LPG			1.56			
Light utility	Diesel			2.71			
Etc..							
Totals							
Average intensity							
Target intensity						105	105

The approved emissions intensity target should be included

The report should also contain a brief update on any trials being conducted and any watching briefs, including at minimum:

1. Effectiveness of hybrids and battery EVs in the fleet
2. Cost effectiveness of electric rubbish trucks

The RAC provides analyses the running costs of most of the main vehicles used in WA to allow comparative analysis between vehicles.³⁹

Green Fleet initiatives⁴⁰, including using alternative fuels, purchasing hybrid vehicles, using smaller cars and trucks as well as implementing electric vehicles (when appropriate) will continue to maximize efficiencies, reduce energy costs while meeting the One Planet Living principles.

³⁸ <http://www.e-stralian.com.au>

³⁹ <https://rac.com.au/car-motoring/info/buying-a-car/running-costs>

⁴⁰ <http://www.greenfleet.com.au/About-us/About-Greenfleet>

(d) Enable electric vehicles through charging points and carpark design.

The City was planning a high-speed charger near Esplanade Park, this plan should be reinstated once the budget allows.

This report also discusses (see section 10.4.2) the option of re-deploying the FLC PV system to run an off-grid charging point, if it cannot be reconnected to the grid.

All new carparks should be designed such that an electrical supply, terminated in large distribution boards within the carparking area, sufficient to supply 5% of bays with 15amp charging points. The charging points need not be installed initially but should allow for City, carpark operator, tenant or a retailer whose customers use the carpark to install charging points without the need to add new supply circuits to the main power distribution board. Boards within the carparking area should be sized to allow for energy meters on each charging circuit.

(e) Identify vehicle types that could be procured as electric

Electric Vehicles (EVs) come in two main types: Battery electric (BEV) and Hybrid-electric (HEV, PHEV) vehicles. BEVs have a purely electric drive system, with electricity as the fuel, requiring regular charging input. HEVs have both electric and internal combustion power plants, and charge the electric system through regenerative braking only. PHEVs are HEVs that generally have a larger battery and are able to be charged from an external power supply.

The key to electric vehicles is the battery price. Battery prices continued the downward price trend of recent years. On a per-kilowatt-hour basis, costs have fallen from US\$542 in 2012 to around US\$139 in 2017⁴¹, according to analysis by Benchmark. As batteries account for approximately 40% of the cost of an electric car, this reduction is improving the comparison compared to conventional cars. A recent UBS report published in RenewEconomy in May 2017 indicated that “total cost of consumer ownership [of electric cars] can reach parity with combustion engines from 2018.”

Although an electric car may be more expensive compared to a conventional car to buy new, over the lifecycle of ownership, taking into consideration, maintenance, cost of fuel, insurance, and all the other factors that are part of the total cost of ownership, electric cars may be cheaper by 2018.

Early opportunities:

- Passenger vehicles are likely to be the earliest opportunity. The City is already trialling two hybrid Toyota Corollas, which are reportedly working well in the fleet, although limited information is being gathered about the overall business case for these.
- Light commercial vehicles are already appearing in Europe, and occasionally in Australia, with electric drive options.
- Rubbish trucks, with their regular stop start cycle, would make excellent hybrid or full electric vehicles. Officers have investigated a trial in New Zealand⁴² but report that these are cost prohibitive at this stage.

(f) Identify opportunities to reduce vehicle size

This recommendation should need little explanation but seeks to remind decision makers that the natural human instinct to allow some contingency in the choice of vehicle size can result in a potentially large consumption of transport fuel and energy for no actual function.

⁴¹ MIT Technology review, Michael Reilly May 2017

⁴² http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11705404

(g) Enable route efficiency

There are many services that can assist in route planning, both for regular, planned routes, and for staff using sat-nav in vehicles. The City has begun trials with a system to assist in the design of rubbish truck routes and other regular routes.

(h) Consider bio-fuels, particularly bio-diesel for heavier vehicles.

Bio-diesel has been trialled in the City fleet. Problems encountered were those typical of changeover to biodiesel: the high purity of biodiesel tends to work to dislodge build-ups of solids in the fuel system, which then accumulate in filters to cause blockages. These blockages are sometimes wrongly attributed to the biodiesel, and typically do not re-occur after filters have been changed out.

The reason cited for discontinuing biodiesel use was concern over the voiding of manufacturer warranties. It would be illegal to void a warranty that covers parts and workmanship over an un-related fuel choice. However, there is a perception problem here that could cause additional work where a warranty claim is made, and is a barrier to uptake.

Ethanol is an option for petrol replacement but the same warranty issue exists for higher ethanol content fuels. Some vehicles are 'ethanol-ready', generally up to 85% ethanol in Australia, but these are not common and neither is the supply of E85 through service stations.

The source of the feedstock and energy used in the conversion of the feedstock to biofuels needs to be considered. Employees are concerned that higher percentages of biofuels may void vehicle warranties. The effort/ reward of using biofuels need to be considered in light that biofuels constitute a small cost of the overall energy expenditure and greater benefits can be captured by focusing on other energy savings throughout the City's portfolio. That said, we are supportive of using increased volumes of biofuels in the fleet if there are justifiable environmental benefits.

(i) Lower emission choices through novated lease cars

Staff personal work vehicles and salary sacrificed vehicles are managed through Human Resources, rather than the fleet manager. There may be opportunities to present staff with greener choices in this system, potentially through identifying the total cost of ownership benefits of electric vehicles.

10.11.5 Data

Fuel consumption in the City of Fremantle light vehicle fleet is reported through the BP fuel card system. This data has been summarised to identify the scale of opportunities for lower emissions options, although some uncertainty exists regarding the data provided. The summary below includes estimated emissions based on the most recent National Greenhouse Accounting Factors (2016).

Table 13: Estimated fuel consumption and emissions 2016-2017

Type	Number vehicles	Fuel cons (L/100km) [Corolla 6.7, National av. 11]	Average annual travel (37km/day national average)	Quantity Fuel (L/year)	Fuel Type	Emissions Intensity (kg CO2e / L) ⁴³	Emissions (kg CO2e / year)
Light Passenger	20	6.7	270100	18096.7	ULP	2.32	41,984
Ute	32	11	432160	47537.6	Diesel	2.71	128,827
Van	7	12.7	94535	12005.945	Diesel	2.71	32,536
Bus	2	38.2	27010	10317.82	Diesel	2.71	27,961
Machinery	2	38.2	27010	10317.82	Diesel	2.71	27,961
Rubbish trucks	4	38.2	54020	20635.64	Diesel	2.71	55,923
Total	63					Total emissions	315,193

There is also a quantity of fuel (mainly diesel) that is dispersed through the City Depot supply. Details have not been made available at the time of writing.

10.11.6 Uncertainty in data

The fleet data provided is a combination of reports through the fuel card system from the provider, BP, and depot fuel consumption figures. In this the 2016-2017 data has been used as the reporting does not align to financial years. There is some doubt about the validity of this data as the fuel consumption figures for light vehicles appear inconsistent and, particularly for the light passenger vehicles, very high. For these light passenger vehicles, the average fuel consumption is roughly double the manufacturer claimed figures, and shows a large range from the expected figure at the low end to approximately 5-times the expected figure at the high end.

10.11.7 Process Notes

These recommendations are around the development of business cases for each item. The City should enable officers to test the viability of each recommendation and advise.

10.11.8 Interaction with Other Actions

Energy Plan Status Updates: Fleet section as described here to be included.

Data reform: A different method of tracking travel distance against fuel consumption is required – the current odometer readings are very unreliable in many cases.

⁴³ <http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-aug-2016>

10.11.9 Triple Bottom Line and One Planet Living (OPL) Analysis

(a) Financial Analysis

Over the period of the Energy Plan, it is expected that low emissions vehicle options will begin to compete financially of their own accord. 2018 has been identified as a likely horizon for EVs to become the cheaper option for total cost of ownership.⁴⁴

There is not sufficient, credible data available to support a complete analysis of moving to a lower emissions fleet. The fuel cost per kilometre for a BEV can be expected to be approximately 50% that of an equivalent Internal Combustion Engine (ICE) vehicle. Hence, the payback on any capital cost uplift can be easily estimated by someone with access to the correct data. Failing this, the RAC, and probably other sources, can be expected to be publishing total cost of ownership figures for electric options to enable comparison. If a given vehicle has sufficient range to cover a typical high-use day then it will make an effective fleet option. HEVs and PHEVs may have similar cost-per-kilometre performance to BEVs, but have higher maintenance costs. The analysis will be straightforward for a fleet manager.

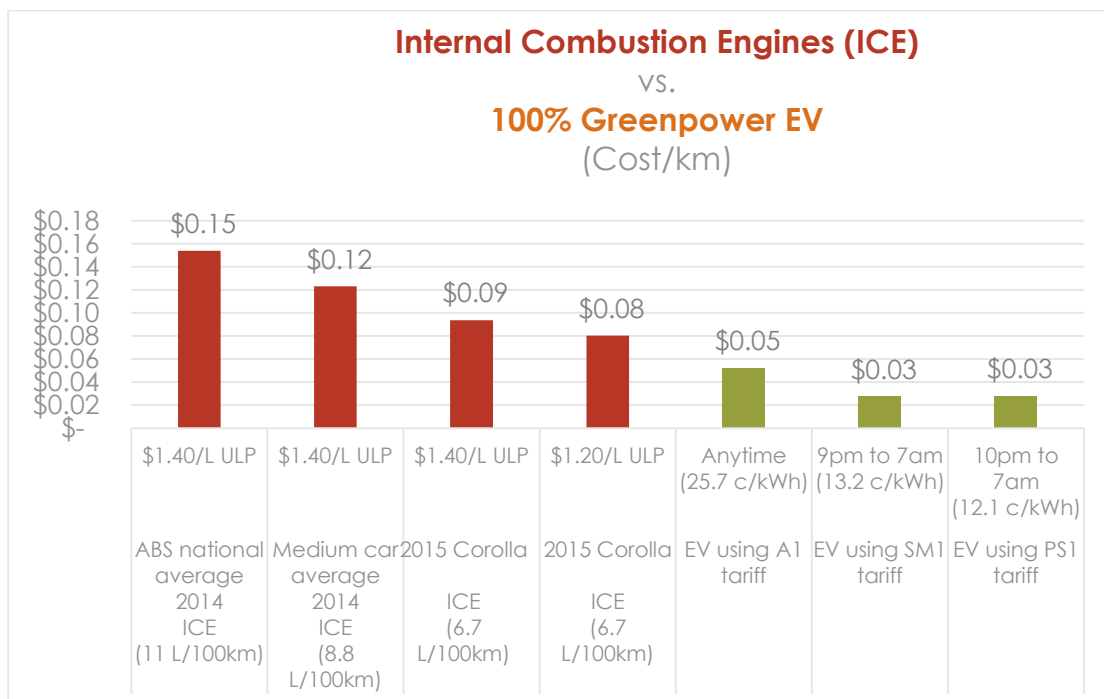


Figure 18: Cost per kilometre comparison of various fuel options (JBA 2016)

(i) Assumptions

- EV assumed efficiency: 0.2 kWh/km (conservative).
- BEVs also show reduced annual maintenance costs that has NOT been included in this analysis.

(b) Environmental Analysis

(i) Emissions Impacts

Electric vehicles generally have dramatically lower emissions profiles than petrol or diesel fuelled vehicles, even when charged from standard grid electricity. The following table makes a comparison of a modern petrol vehicle, a BEV charged from the grid, and a 100% Greenpower charged BEV.

⁴⁴ UBS report published in RenewEconomy in May 2017

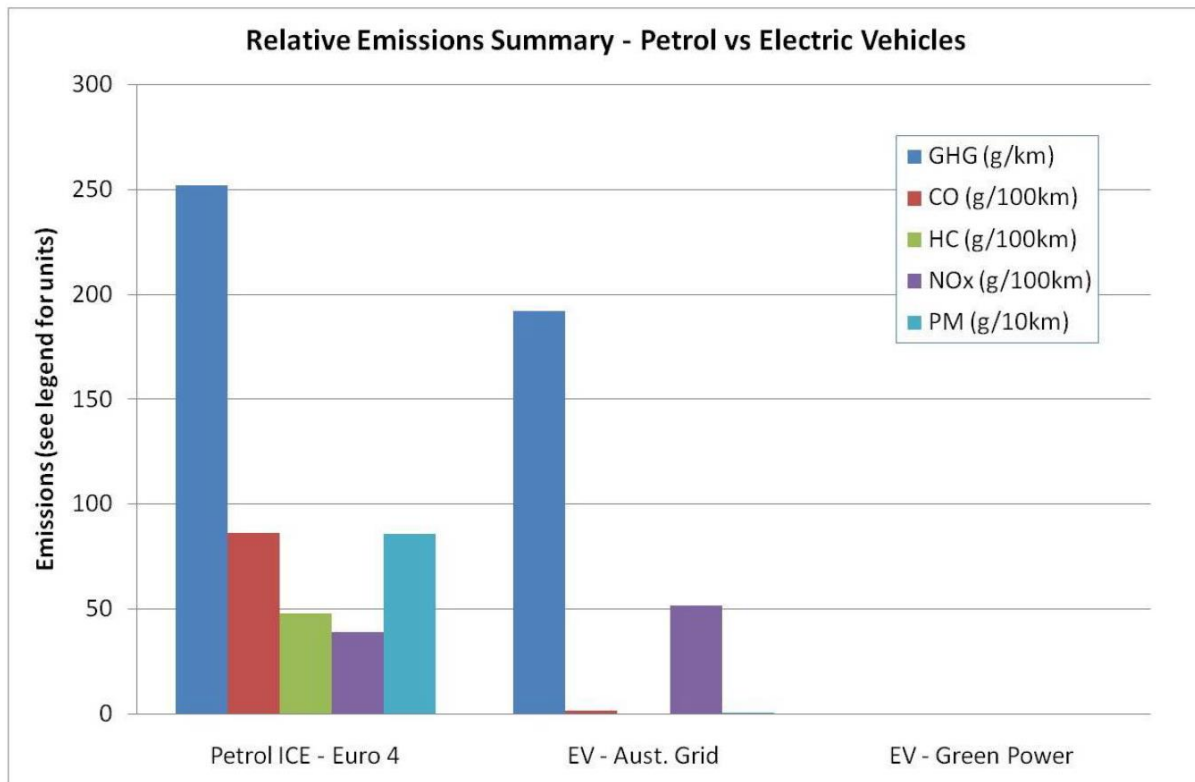


Figure 19: Environmental Attributes of Electric Vehicles in Australia, Dr Andrew Simpson, Curtin U (2009)

(ii) Materials, Waste and Recycling

EV batteries are typically lithium based, and bring with them some concerns around the sustainability and recycling of materials. Lithium is highly recyclable; however, batteries need to be designed to be easily deconstructed to make this process effective.

Some information is provided here: <http://www.batteryrecycling.org.au/recycling/lithium-ion-batteries>

(c) Social Analysis

- Reducing greenhouse gas emissions is a social imperative for preserving human systems.

(d) OPL review

The Corporate Target published in the City’s 2016 OPL report is:

The City of Fremantle will increase staff sustainable transport use by 15% by June 2016 and 30% by 2020, from a 2010 baseline. The City will also reduce corporate transport emissions by at least 30% by 2020, from a 2010 baseline.

A concerted move to EVs is the only viable option for achieving the stated emissions target. The Climate Change Authority 2025 target recommended for adoption in this report represents a greater reduction than the OPL 2020 target, and is therefore consistent with the OPL principle.

10.11.10 Risk Review

Risk	Possible Impact	Likelihood	Response
Staff resistance to alternative technologies	Less use of the newer low emissions vehicles.	Very low for HEVs, and low for PHEVs. Higher for BEVs due to 'range anxiety' and less familiarity.	Education (training in understanding the range estimator and charging regime). Choice of attractive BEV vehicles.
Limited charging options away from CoF.	Stranded vehicles.	High (reducing as charging infrastructure increases).	Ensure that a mobile fast charge, or vehicle trailer, is available at quick response through the City or a roadside assist service.

10.11.11 Program for Implementation

Incentivise alternative transport choices.	Implementation
Set targets for fleet emissions intensity.	Stage 1
Create a regular reporting schedule so that progress towards the target can be tracked.	Stage 1
Enable electric vehicles through charging points and carpark design.	In line with roll out of new carparks
Identify vehicle types that are suitable to be procured as electric vehicles over the coming years.	Stage 1 and ongoing (reviewed in Regular Reporting)
Identify opportunities to reduce vehicle size	Ongoing
Enable route efficiency	Stage 2 or 3 – requires research and business case development
Consider bio-fuels, particularly bio-diesel for heavier vehicles.	Ongoing
Identify opportunities to incentivise lower emission choices through the novated lease / salary sacrifice system.	Stage 2

10.11.12 Benchmarks and other measures to be included in reporting

- As per suggested reporting content in the body of the Management Action

10.11.13 Summary of Management Action

Action	Sustainable Corporate Transport
Final Recommendation	<ol style="list-style-type: none"> 1. Incentivise alternative transport choices. 2. Set targets for fleet emissions intensity. 3. Create a regular reporting schedule so that progress towards the target can be tracked. 4. Enable electric vehicles through charging points and carpark design. 5. Identify vehicle types that are suitable to be procured as electric vehicles over the coming years. 6. Identify opportunities to reduce vehicle size 7. Enable route efficiency 8. Consider bio-fuels, particularly bio-diesel for heavier vehicles. 9. Identify opportunities to incentivise lower emission choices through the novated lease / salary sacrifice system .
NPV / LCoE	na
Renewable Energy (kWh/year)	na
Emissions (+/- Tonne CO2e/year)	TBC Tonne CO2e/year [data currently available is not adequate for estimating emissions – a methodology has been provided]
Leadership value	City hybrids and any BEVs should feature large signage communicating the benefits.
OPL impacts	<p>Zero Carbon [✓ ✓] (impact will be gradual)</p> <p>Sustainable Materials and Zero Waste [x] (more work on material reuse and recycling required in car industry)</p>
Plan Stage to implement	Stage 1 – 3 (ongoing, various initiatives)
Interaction with other Actions	<ul style="list-style-type: none"> •Energy Plan Status Updates: roll-out of low emissions transport options to be tracked •Data reform: Vehicle fuel and emissions data collection to be standardised and performance benchmarked <p>Increased EV use will increase electrical load. This has been allowed for in calculations of predicted load profile to 2025.</p>

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Appendix 1.

Below is the response from Synergy received from Ana Farla on 24 August 2017 in answer to questions from the meeting on 27 July 2017. These points relate to section 10.3 of the Management Actions – portfolio approach. This should be used as a reference document as part of ongoing negotiations with Synergy.

Portfolio working group - status

31 July 2017				
Questions	Status	Responsibility	Est Deadline	Synergy's comments
1) As this is a new project that may impact existing tariffs how should this project be organised?	As the City of Fremantle's issues are outside the current tariff system it is proposed to call this a pilot project and determine specialised tariffs for this project. It was agreed this is where the market is going and Synergy wants to be proactive in addressing these issues. Synergy needs to discuss internally and establish the pilot project	Ana Farla	11 Aug 2017	Synergy advised that we will investigate internally if this can be offered but did not commit to proactively address this issue, however we are actively reviewing the different options and will definitely keep the City of Fremantle updated.
2) Does Synergy have a product that is sourced from renewable energy that City of Fremantle could purchase as a commercial customer? Or is Greenpower the only option? https://www.synergy.net.au/large-business/Energyproducts/Green-energy-options/ If there are alternatives, such as underwriting a Power Purchase Agreement from a new renewable project, could you please provide details of the cost of this product and the systems in place to support that supplies under this product are met by renewable energy?	Synergy to review internally and respond. Synergy may make a proposal for one of their existing projects. The pricing should be comparable to other projects the City of Evaluating.	Ana Farla	11 Aug 2017	Synergy does not have any existing projects relating to Power Purchase Agreements and can only offer Natural Power but we will keep the City of Fremantle informed if we have any new projects in that regard.
3) City of Fremantle are investigating installing rooftop PV on a range of sites. Some of these sites may have significant import to the network at particular times. City of Fremantle would like to use this energy at other locations within their portfolio. Does Synergy have arrangements that would allow City of Fremantle to manage all its sites as a portfolio? That would allow energy imported at one location be consumed at another location with Synergy supplying the shortfall. All this would occur behind the meter (the meter is at Knutsford).	Synergy agreed to allow generation at one location to be netted out with consumption at other locations within the City of Fremantle Portfolio. Synergy will organise the billing. This can start immediately. Synergy already does this with some other industrial customers. The calculations will be completed on a 30 min basis and billed monthly. Information is to be collected remotely from the dual flow remote data collection smart meters that Western Power will install. August's invoice needs to be updated.	Ana Farla	11 Aug 2017	Synergy is actively investigating options available regarding solar generation and offsetting the City of Fremantle consumption, however this is not an existing service currently provided by Synergy.
4) City of Fremantle may look to underwrite a small renewable generator in the Fremantle area. Would Synergy facilitate the supply from such a generator being included in the City of Fremantle's supply arrangements? For example, City of Fremantle could "free issue" the electricity to Synergy at the entry point and Synergy would only charge network charges and a retail margin on this electricity?	Synergy agreed that external generation can be included in the City of Fremantle Portfolio. To be confirmed by Synergy.	Ana Farla	11 Aug 2017	Synergy agreed to consider if this is possible and liaise with Western Power, however we did not agree to add external generation to the City of Fremantle's Portfolio and we will keep the City of Fremantle informed if this is possible.
5) Can Synergy split street light invoices into energy usage, maintenance and replacement and new installations? Currently there is only one daily price.	Synergy asked for an example invoice to be created by the City of Fremantle to show what they want.	Cameron Edwards	4 August 2017	Synergy do not have the billing capability to split street light invoices.
6) If the City of Fremantle were to build additional renewable generation within its boundaries, would Synergy be interested in owning and or operating it. The focus will likely be solar PV and other forms have expressed and interest however Synergy is the incumbent retailer.	Potentially. Need to finalise the portfolio approach first.	Ana Farla	11 Aug 2017	Synergy will consider if this is possible and will keep the City of Fremantle updated
7) Can the energy for the street lighting be included in the portfolio so that renewable energy can be used?	Although this hasn't been done before the amount of energy used by street lights can be calculated. Synergy needs to check internally whether this can be included in the portfolio. This will also mean splitting the operations and maintenance charges.	Ana Farla	11 Aug 2017	This is not currently possible based on our billing system limitations however we are investigating other options and will keep the City of Fremantle updated
8) What is the type and cost of the dual flow remote data collection smart meters that will be installed?	To be determined by Western Power	Julie Hodges	11 Aug 2017	