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Solar PV systems reduce the City's carbon emissions and energy costs.
Snapshot of our plan

Our vision
- The City is a recognised innovator and leader in the local government sector, taking action to reduce carbon emissions and invest in renewable energy
- The City conserves energy and its facilities, parks and reserves are energy efficient
- The City is 100% powered by renewable energy
- Our people are engaged and take positive action
- Our data enables strategic decision making and reporting.

Science-based carbon emissions reduction
Carbon emissions reductions are considered ‘science-based’ if they comply with the Paris Agreement to limit global average temperature increase to below 2°C above pre-industrial levels. In 2016, the City calculated it would need to reduce corporate carbon emissions by 38% by 2030 to comply with the Paris Agreement.

To achieve this, the City would need to reduce total annual emissions to 9,217 tonnes carbon dioxide equivalent emissions (t CO₂-e) in 2030. This provided the City with guidance as to the minimum carbon emissions reduction effort to be achieved.

Carbon emissions reduction target
The City desires to go beyond its minimum requirements and aims to achieve the following target from a 2018/19 baseline:

Reduce corporate carbon emissions by 70% by 2030.

To achieve this requires a reduction in total annual emissions to 4,079 t CO₂-e in 2030.

Carbon emissions reduction target

<table>
<thead>
<tr>
<th></th>
<th>2018/19 Baseline</th>
<th>2025 KPI</th>
<th>2030 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon emissions reduction target</td>
<td>-</td>
<td>at least 35%</td>
<td>70%</td>
</tr>
<tr>
<td>Total emissions (t CO₂-e)</td>
<td>13,596</td>
<td>8,837</td>
<td>4,079</td>
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<tr>
<td>Emissions reduced (t CO₂-e)</td>
<td>-</td>
<td>-4,759</td>
<td>-9,517</td>
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</table>
Our key priority

The key focus of this Plan is to reduce the consumption of grid-powered electricity or replace it with renewable sources in order to decrease carbon emissions in the most efficient manner.

The electricity from the South West Interconnected System (SWIS) that powers the City is a relatively carbon intensive energy source. While grid-powered electricity accounts for only one-third of the City’s total energy consumption, it contributes almost two-thirds of carbon emissions.

Our strategy

- Continue energy conservation and efficiency projects
- Continue solar photovoltaic (PV) installations and investigate other renewables and emerging technologies
- Procure a power purchase agreement to achieve 50% renewable energy KPI by 2025 and 100% renewable energy target by 2030.

Renewable energy target

The City aims to:

Source 100% of total electricity demand from renewable energy by 2030.

We currently produce 0.62 GWh of solar energy annually, or 5% of the City’s total electricity consumption. To achieve the target requires the production and/or procurement of around 11.6 GWh of renewable energy annually, based on 2018/19 energy consumption.

Our programs

- **Energy conservation and efficiency**: avoid energy consumption by using smart technology and control systems to reduce the amount assets are used, and ensure assets are efficient and minimise energy consumption when in use, especially at night
- **Renewable energy**: increase the proportion of energy provided by renewable sources via solar PV, other renewables, new and emerging technology and a power purchase agreement
- **Engagement**: enable staff to reduce the impact of their individual actions and corporate projects on energy consumption and carbon emissions, and promote progress of the Plan
- **Data and reporting**: improve data management for strategic decision making and reporting.

### Renewable energy target

<table>
<thead>
<tr>
<th></th>
<th>2018/19 Baseline</th>
<th>2025 KPI</th>
<th>2030 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable electricity as % of total electricity consumption</td>
<td>5%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Renewable energy generated or purchased</td>
<td>0.62 GWh</td>
<td>5.8 GWh</td>
<td>11.6 GWh</td>
</tr>
</tbody>
</table>
Our action plan

Energy conservation and efficiency program

- Carry out facility and equipment audits to identify energy retrofit projects
- Continue energy efficiency projects, replacement of irrigation pumps using efficient technology, and nine-year floodlight LED plan
- Install business software to reduce number of printers and to enable overnight energy reductions
- Develop Environmentally Sustainable Design (ESD) standards and scorecard to ensure all refurbishment and new build projects contribute to reducing energy consumption
- Demonstrate best practice in new-build design and construction by building an energy-efficient showcase building
- Review irrigation pump upgrades and irrigation and floodlighting control systems to determine opportunities for efficiencies.

Renewable energy program

- Continue program of installing renewables, including facility audits and review of new technologies to identify priority projects, until saturation point is reached
- Review options for renewable energy on City facilities and land, project the City’s future renewable energy generation, and complete a tender process for a power purchase agreement (PPA) to purchase renewable energy
- Develop Environmentally Sustainable Design (ESD) standards to consider renewable energy systems in all new-build projects where the return on investment is less than seven years
- Design and build a net-zero-emissions showcase building that will produce more energy than it will use
- Develop and implement a showcase battery storage project to determine its feasibility for wider-scale implementation.

Engagement program

- Report on energy consumption and carbon emissions in the Annual Report and corporate Sustainable Energy Report
- Review existing Sustainability Policy and Project Charter to ensure energy consumption and carbon emissions impacts are adequately addressed
- Report energy consumption and carbon emissions periodically to relevant managers
- Develop a staff and building-users behaviour change campaign and a community awareness campaign
- Drive progress of this Sustainable Energy Action Plan (Corporate) through a steering group with a high-level project sponsor and relevant managers from across the business
- Demonstrate commitment to reducing carbon emissions by joining the Cities Power Partnership.

Data and reporting program

- Use and improve online systems to manage energy, emissions, renewables and building data
- Map energy supplies at remaining complex and multi-use sites to improve understanding of energy consumption by individual assets
- Produce a single data management system for main meter, renewable energy and sub-meter data
- Define business processes and responsibilities for data collection, verification, authorisation, change management and reporting
- Develop a business case for installing additional sub-meters at tenanted sites and automatic meter readers on main electricity supplies to improve data collection and on-billing.
Replacing lighting with energy-efficient light-emitting diodes (LED) has contributed to reducing the City’s carbon emissions.
Background

The City of Stirling has a long history of measuring, tracking and reducing its energy consumption, carbon emissions and costs.

The City has demonstrated a long commitment to measuring, tracking and reducing its energy consumption, energy costs and carbon emissions. The City produced an endorsed Local Greenhouse Action Plan in 2003 and reported on this until 2009. In 2010, Council endorsed the WALGA Climate Change Declaration and the City began publicly reporting on corporate energy consumption and carbon emissions via its Annual Report.

In 2012, the City produced a Corporate Energy Management Plan that identified key actions to reduce carbon emissions and energy costs. The Corporate Energy Management Plan led to two successful federal energy efficiency grants – the Community Energy Efficiency Program Grant and the Local Government Energy Efficiency Grant. The grants enabled a range of corporate energy efficiency projects. Building on the success of these projects, the City produced subsequent plans and reports, and implemented an ongoing program of energy reduction upgrades and solar PV installations to its facilities.

Strategic development

The City pledged in its Strategic Community Plan 2018 – 2028 under the key result area of Natural environment, outcome N1: Sustainable natural resources to:

Reduce the City’s energy use and greenhouse emissions.

In its Corporate Business Plan 2018 – 2022, the City made the commitment under the key result area of Natural environment – Sustainable natural environment to:

Develop and implement a Sustainability Strategy – Energywise.

This Sustainable Energy Action Plan (Corporate) aims to set a target and clear direction to focus the City’s actions to reduce carbon emissions and contribute to global efforts to avoid the worst effects of climate change.
Our climate is changing

“The science is clear: climate change is occurring and greenhouse gas emissions from human activities are the dominant cause.” (WALGA Climate Change Policy 2018)

Australia’s climate is changing; we are facing a more uncertain climate future with more frequent and extreme weather events. Some Australian councils, such as Darwin, Hobart, Melbourne and Sydney City Councils, have declared this a ‘climate emergency’.

Since 1910, the temperature has warmed by around 1°C, resulting in the increased frequency of extreme heat events and marine heatwaves. Sea levels around Australia are rising, increasing the risk of inundation in coastal areas. In Western Australia, 2018 was the sixth warmest year on record with mean maximum temperatures above average across the state and a decrease in the April to October rainfall across the South West (Bureau of Meteorology, 2018).

Carbon emissions and climate change

Greenhouse gas emissions (carbon emissions) continue to increase globally and are acknowledged by the scientific community as the main contributor to climate change.

The energy that powers the City of Stirling’s operations and services comes from both non-renewable and renewable sources. When the City uses non-renewable energy supplies (grid-powered electricity, natural gas, and fuel in the form of diesel and petrol and LPG), carbon emissions are released into the air.

There is a finite amount of carbon emissions the earth’s atmosphere can absorb before critical temperature thresholds are reached; this is estimated to be 1,010 gigatonnes (Gt) of carbon dioxide equivalent emissions ($\text{CO}_2$-e) to keep average temperature increase to below two degrees Celsius and 400 Gt $\text{CO}_2$-e to keep average temperature increase to below 1.5 degrees Celsius (Science-based Targets initiative, 2017). This sets a ‘carbon budget’ for governments, regardless of growth in population or services.

United Nations Paris Agreement

Australia is a signatory at a federal level to the United Nations Paris Agreement 2016, which sets a goal to hold the rise in global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the increase even further to 1.5°C.

The Australian Federal Government has set a target to reduce carbon emissions by 26% to 28% by 2030 (on a 2005 base year). Australia is not on track to achieve this, with the latest Department of Environment and Energy report stating emissions may be reduced by only 16% by 2030 (Department of the Environment and Energy, 2019).

Local government has a key role to play in contributing to national and international emissions reduction targets. In its Climate Change Policy 2018, the Western Australian Local Government Association (WALGA) recognises that local government is ‘in a unique position to drive and implement mitigation programs, foster innovation and support sustainability’.
Scarborough Beach Pool has a 6-star energy rating and is heated by renewable geothermal energy.
Solar black matting at Stirling Leisure Centres – Leisuerpark – Barga heats swimming pool water.
Our vision and targets

Our vision

• The City is a recognised innovator and leader in the local government sector, taking action to reduce carbon emissions and invest in renewable energy
• The City conserves energy and its facilities, parks and reserves are energy efficient
• The City is 100 per cent powered by renewable energy
• Our people are engaged and take positive action
• Our data enables strategic decision making and reporting.

Our baseline

In 2018/19, the City, from the key sources of grid-powered electricity, natural gas, and fleet fuel (diesel, petrol and waste contractor diesel):

• Consumed 126,918 gigajoules (GJ) of energy
• Generated 13,596 t CO$_2$-e emissions
• Spent $4.95 million.

Emissions are measured from corporate activities, i.e., from energy used in the delivery of City services by the City’s building facilities, parks and reserves, fleet, and waste contractor vehicles (Appendix 1).

Carbon emissions breakdown – 2018/19

- 8,112 t CO$_2$-e Electricity
- 1,222 t CO$_2$-e Natural gas
- 3,242 t CO$_2$-e Fleet fuel
- 1,020 t CO$_2$-e Contractor fuel
Science-based carbon emissions reduction

Carbon emissions reductions are considered ‘science-based’ if they comply with the Paris Agreement to limit global average temperature increase to below two degrees Celsius above pre-industrial levels.

In 2016, the City calculated its science-based emissions reduction using the Sectoral Decarbonisation Approach. This is a standard method for companies and organisations to calculate their contribution to the Paris Agreement commitment. The City’s science-based emissions reduction is to reduce corporate emissions by 38 per cent by 2030.

To achieve this, the City needs to reduce total annual emissions to 9,217 t CO2-e in 2030. This provides the City with guidance as to the minimum carbon emissions reduction effort that should be achieved.

Carbon emissions reduction target

The science-based carbon emissions reduction is the minimum that we aim to achieve. However, the City desires to go beyond its minimum requirements and aims to achieve the following target from a 2018/19 baseline:

Reduce corporate carbon emissions by 70 per cent by 2030.

To achieve this requires a reduction in total annual emissions to 4,079 t CO2-e.

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Carbon emissions reduction targets

Other Australian cities have developed carbon emissions reduction targets. The focus of the targets and inclusion of sources varies; many adopt ‘carbon neutral’ or ‘net zero emissions’ policies which do not necessarily aim to reduce emissions. The City of Stirling target is ambitious compared with other councils that have the same focus and timescale.
Floodlighting, car park lighting and facilities all contribute to the City’s carbon emissions when in use.
Renewable energy target

The City aims to:

Source 100 per cent of total electricity demand from renewable energy by 2030.

We are currently producing 0.62 gigawatt hours of solar energy annually, or five per cent of the City’s total electricity consumption. To achieve the target requires the production and/or procurement of approximately 11.6 gigawatt hours of renewable energy annually, based on 2018/19 electricity consumption. This is achievable with a combination of investment in renewable energy systems and purchasing renewable energy via a power purchase agreement (PPA).

## Renewable energy production targets

Other Australian cities have developed renewable energy production targets. It is important to note that the criteria of the targets vary; many cover only some assets that consume electricity, for example buildings, and not the total electricity consumption. The City of Stirling’s target to source 100 per cent from renewable energy by 2030 covers its total electricity demand.
Key priority – grid-powered electricity

<table>
<thead>
<tr>
<th>2018/19</th>
<th>Electricity</th>
<th>Fuel</th>
<th>Gas</th>
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<tr>
<td>% of energy</td>
<td>33%</td>
<td>47%</td>
<td>20%</td>
</tr>
<tr>
<td>% of emissions</td>
<td>60%</td>
<td>31%</td>
<td>9%</td>
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The City’s carbon emissions are measured from the key sources of grid-powered electricity, natural gas, and fleet fuel (diesel, petrol and waste contractor diesel).

Grid-powered electricity accounts for one-third of the City’s total energy consumption, but almost two-thirds of carbon emissions. The electricity from the South West Interconnected System (SWIS) that powers the City is primarily produced from coal-fired power plants, with some input from renewable solar and wind, and is a relatively carbon-intensive energy source.

Natural gas contributes the least to the City’s energy consumption and carbon emissions and is a relatively low-carbon energy source. Natural gas is used by the City for heating, hot water and to a lesser extent cooking. Improvements to natural gas appliances and infrastructure are already made as part of end-of-life planning and further actions are not a key priority of this plan.

Fuel contributes almost half of the City’s energy consumption. The City has an endorsed Fleet Emissions Reduction Action Plan 2015 – 2020 to drive down carbon emissions from fuel, therefore fuel is not a key priority of this Plan.

The key priority of this Plan is to reduce the consumption of carbon-intensive grid-powered electricity, or to replace it with renewable sources in order to decrease carbon emissions in the most efficient manner.

Two-thirds of the City’s electricity is consumed in facilities, including the administration office, operations centre, waste transfer station, community centres, recreation and aquatic centres, day care centres, food services, and associated lighting (security, street and carpark).

One-third of the City’s electricity is consumed in parks and reserves, including groundwater pumps, irrigation pumps, floodlighting, barbeques, toilet blocks and associated lighting (security and carpark).

Energy costs

The City’s energy costs from the key sources of grid-powered electricity, natural gas and fuel have increased by around $130,000 over the past four years to $4.95 million, despite energy consumption reducing over this same period. This is due to an increase in both supply and unit charges across all energy sources, over which the City has no control. Because of this, reducing energy costs is not a key target of this plan. However, by virtue of reducing energy consumption and investing in renewables, energy costs should reduce in real or comparative terms.
Energy efficiency works at Stirling Leisure Centres - Leisurepark - Balga – were partly funded by government grants and continue to reduce the City’s energy consumption and carbon emissions.
Reducing energy and emissions


Investing in energy reduction initiatives pays off. Energy consumption from the key sources of grid-powered electricity, natural gas, and fuel has decreased by almost three per cent and carbon emissions by nine per cent since 2015/16. Without completing energy reduction projects, energy consumption from these sources would have increased by almost 12 per cent over the same period.

Renewable energy

The City has installed 11 solar photovoltaic (PV) systems on City facility roof space with a total capacity of 685 kilowatt-peak (kWp). The annual production of solar energy has significantly increased over the last four years to 623,543 kilowatt hours (0.62 gigawatt hours). The solar systems currently produce around five per cent of the City’s electricity consumption, with 98 per cent of the solar energy generated being used by the City.

Renewable energy generation

![Renewable energy generation chart]

- Year 2013/14: 58,548 kWh
- Year 2014/15: 60,135 kWh
- Year 2015/16: 104,924 kWh
- Year 2016/17: 215,278 kWh
- Year 2017/18: 475,120 kWh
- Year 2018/19: 623,543 kWh

Projected energy consumption (if no energy saving projects)

- Year 2015/16: 138,957 GJ
- Year 2016/17: 139,303 GJ
- Year 2017/18: 146,706 GJ
- Year 2018/19: 152,776 GJ

Energy consumption

- Year 2015/16: 138,957 GJ
- Year 2016/17: 139,303 GJ
- Year 2017/18: 146,706 GJ
- Year 2018/19: 152,776 GJ

Energy saved

- Year 2015/16: 136,890 GJ
- Year 2016/17: 131,315 GJ
- Year 2017/18: 131,780 GJ
- Year 2018/19: 132,989 GJ
Expansion in facilities

Alongside efforts to reduce energy consumption and carbon emissions, the City continues to grow in resident numbers and services.

Energy consumption from the key sources of grid-powered electricity, natural gas, and fuel has decreased over the past four years. However, when energy consumption is combined with solar energy consumption, total consumption of energy by the City has actually increased over the past two years. One contributor to this is the Scarborough Beach Pool which opened on 22 January 2018 and contributed 6,071 gigajoules (GJ) in the 2018/19 financial year.

In the current four-year program of works, the City has planned to extend clubrooms and create additional public facilities. The expansion of sports lighting for playing fields will increase electricity consumption, even with the use of LED lamps. The installation of energy intensive reverse-cycle air-conditioners in more of the City’s buildings will also increase electricity consumption.

The City cannot continue to increase energy consumption and the resultant carbon emissions as service levels increase. Services provided must be sustainable and meet the community’s environmental expectations. Any increase in energy consumption and carbon emissions will require the City to work harder to reduce emissions elsewhere.

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Corporate energy consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>GJ energy consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015/16</td>
<td>137,268</td>
</tr>
<tr>
<td>2016/17</td>
<td>132,062</td>
</tr>
<tr>
<td>2017/18</td>
<td>133,375</td>
</tr>
<tr>
<td>2018/19</td>
<td>135,178</td>
</tr>
</tbody>
</table>

- **Solar energy**
- **Scarborough Beach Pool**
- **Energy from grid-powered electricity, gas, and fuel**
The City’s increasing demand for energy in new facilities and services is outstripping the outcomes from energy reduction initiatives.
Energy conservation and efficiency program

The City aims to avoid energy consumption by using smart technology and control systems to reduce the amount assets are used, and for assets to be efficient and minimise energy consumption when in use, especially at night.

Key challenges

- **Scale and complexity**: the City has a considerable number of energy-consuming assets with varying physical characteristics, energy consumption profiles and operational controls, making it a challenge to identify the most appropriate and cost-effective energy reduction solutions
- **Retrofitting**: building fabric retrofit projects on an ageing infrastructure can be technically complex and not always cost effective
- **Diminishing returns**: as more is achieved, projects become increasingly difficult to identify and the financial and carbon emissions returns diminish
- **Expectations**: facility users expect a level of comfort in heating and cooling, lighting, and pool temperature; the community expects irrigated parks and lighting for recreation and sporting events
- **Conflicting priorities**: increased lighting levels (LUX) and illuminated areas at sporting grounds, walkways and carparks required to meet Australian Standards may counteract savings from energy efficient light-emitting diode (LED) installation
- **Information and communication technology (ICT)**: the City has an extensive network of ICT equipment, including computers, laptops, servers, printers and displays, diverse users, and an ageing and geographically spread ICT infrastructure
- **Vegetation health**: irrigation is required to keep vegetation healthy and free of pests and diseases
- **System configuration**: irrigation and floodlights are grouped into stations and the configurations do not always enable fine-tuned scheduling control
- **System compatibility**: technology to improve remote floodlighting control is not compatible with existing systems and requires hardware and software upgrades to facilitate
- **Expansion**: the City continues to grow in resident numbers; increasing and improving services to residents can increase energy consumption.

Completed actions – facilities

- **Heating, ventilation and cooling (HVAC)**: upgraded HVAC systems in priority buildings to more energy efficient models; optimised control strategies to reduce the amount that air-conditioning and heating are used; reduced use of HVAC in transient and infrequently occupied spaces
- **Building management system (BMS)**: upgraded BMS to monitor and manage HVAC efficiency at the City of Stirling Administration Centre, three aquatic centres and four libraries
- **Maintenance schedule**: developed outcome-based maintenance schedules at three aquatic centres to ensure that plant and equipment are operating at their most efficient
- **Heating**: efficient condensing boilers installed when boilers reach end-of-life
- **Variable speed drives (VSDs)**: installed VSDs on air-conditioning condenser water pumps in priority buildings and on pool pumps in aquatic centres
- **Lighting**: installed high-efficiency LED lighting and automation for lighting controls (eg, motion sensors) in priority buildings
- **Fixtures, fittings and equipment (FFE) list**: developed a FFE list for staff to use when planning building projects and included energy saving items
- **Environmentally sustainable design (ESD)**: developed ESD guidelines for HVAC, lighting and water fixtures to guide staff when planning building projects
- **ICT**: defined specifications with a new supplier for devices with reduced power requirements. Desktop computers use only 10 per cent and monitors use half the energy of the previous devices.
Completed actions – parks and reserves

- **Hydrozoning**: developed a Water Smart Parks Strategy to define irrigation requirements according to hydrozones, local soil moisture and weather conditions
- **Irrigation schedules**: utilised a centralised irrigation management system (CIMS) to remotely monitor soil moisture and weather, and to program and maintain irrigation run times
- **Irrigation meters**: installed R1 tariff meters on all irrigation sites (while this doesn’t reduce energy consumption, it does utilise reduced overnight electricity costs)
- **Irrigation pumps**: upgraded irrigation pumps and starters with the most energy-efficient fit-for-purpose options as part of a rolling 25-year asset upgrade and renewal program
- **Floodlighting schedules**: used CIMS software to program floodlight brightness (LUX), timing and stations according to user group requirements. Program can be manually overridden if floodlight station is no longer required and floodlight infrastructure can be switched off manually if not needed
- **Floodlighting**: implemented a nine-year upgrade plan to replace existing floodlight installations with more energy-efficient LED lighting based on club requirements.

Current actions

- **Facility energy audits**: complete annual strategic review of existing facilities to identify improvement opportunities, focusing on the top energy-consuming sites and inefficient plant and equipment
- **Rolling four-year program of facility maintenance and refurbishment works**: include projects arising from the audits in the program of works based on an optimal payback of typically four to seven years
- **Energy efficiency projects**: continue HVAC, BMS and lighting upgrade/renewal projects based on condition; upgrade and replace irrigation pumps based on rolling 25-year asset upgrade and renewal program using efficient technology; and complete nine-year floodlight LED plan
- **ICT**: improve business software with the utilisation of Ci Anywhere; this should enable overnight energy reductions
- **ICT**: install ‘follow-me’ printing to reduce the number of printers and the amount of wasted printing.

New actions

- **Thermal comfort guidelines**: for City buildings to outline effective summer and winter air temperature and building zone settings on HVAC systems
- **Develop environmentally sustainable design (ESD) standards and scorecard**: review ESD guidelines and develop methodology to ensure design and specification of refurbishment and new build projects include building thermal performance (eg, insulation, solar design and shading), infrastructure to reduce energy consumption, and high energy-star ratings for equipment and appliances
- **Energy-efficient showcase building**: demonstrate best practice in new build design and construction, including careful selection of materials and clever design such as shading and optimal orientation aspects
- **Irrigation upgrade review**: produce a business case to upgrade pumps to more energy efficient models before their 25-year end-of-life
- **Irrigation and floodlighting control review**: produce a business case to investigate fine-tuned control scheduling by revising station configurations and using new control systems recently introduced to the market.
Renewable energy program

The City aims to be 100 per cent powered by renewable energy sources. Renewable energy does not burn fossil fuels and therefore does not produce carbon emissions in operation.

Key challenges

- **Diminishing returns**: as more renewables are installed, space and opportunity for additional systems based on current technology decreases, and the cost savings and carbon emissions returns diminish
- **Capacity**: the total capacity for solar PV installation on existing assets is unknown and potential for other renewable technologies has not been determined
- **Energy use profile**: current solar PV technology has the best payback when used on-site; facilities with low daytime energy use may not benefit
- **Cost effectiveness**: storing renewable energy (eg, via batteries) to use outside of generation hours is not yet cost effective, with an on-average 10-year warranty and 17-year payback
- **Technology**: new renewable energy technology is emerging and becoming increasingly available and cost-effective. This provides opportunities but also uncertainties
- **Decentralisation**: new methods to supply and purchase renewable energy, such as peer-to-peer trading and power purchase agreements (PPAs), are emerging but there is limited information on their feasibility in a Western Australian local government context
- **Site constraints**: use of renewable energy in parks and reserves is limited due to their overnight energy use profile and lack of roof or available ground space.

Completed actions

- **Solar PV**: installed 11 systems on operational buildings with a total capacity of 685 kilowatt peak (kWp)
- **Solar black matting**: installed solar black matting at Stirling Leisure Centres – Leisurepark – Balga to heat swimming pool water
- **Solar hot water**: installed 19 solar hot water systems on community facilities
- **Pool heating**: installed a geothermal pool heating system at Scarborough Beach Pool.

Current actions

- **Rolling four-year program of works**: continually review new technologies and facility audits to identify priority buildings and specific renewable projects to deliver
- **Projects**: continue to install solar PV systems at suitable facilities until saturation point is reached.

New actions

- **Renewable energy review**: review options and opportunities for generation of renewable energy, including solar PV installation on City facilities and land; geothermal on aquatic centres; wind and other renewables; batteries and peer-to-peer trading
- **Renewable energy generation plan**: project the City’s energy generation from installed renewables at 2025 and 2030
- **Power purchase agreement**: review options and opportunities for a power purchase agreement (PPA). Complete a tender process to procure renewable energy to fill any gap identified by the renewable energy review and renewable energy generation plan
- **Develop environmentally sustainable design (ESD) standards**: incorporate renewable energy systems into the ESD guidelines for consideration for all new-build projects where the return on investment is less than seven years
- **Net-zero-emissions showcase building**: include renewable energy systems that will produce more energy than the building will use
- **Battery storage trial**: develop and implement a project to showcase battery storage on a building to determine its feasibility for wider-scale implementation.
What are batteries, peer-to-peer trading and PPAs?

Batteries allow the storage of solar energy for use outside of solar generation periods. They may enable the installation of solar panels at sites that have high evening use, such as recreational facilities and reserves hired for evening sporting events.

Peer-to-peer trading involves excess renewable energy generated at one site being sold or ‘transferred’ to other site/s. It can improve the economics of renewables by enabling the energy generated to be used across more than one site and allowing installation of larger systems than might otherwise be viable. Peer-to-peer trading is an emerging concept, and is not yet available for the City to utilise. The main barriers are regulatory (market rules), technical (metering) and market-based (establishing a pricing structure). However, these are changing quickly and opportunities may open up in the near future.

A potentially cost-effective and large-scale way for the City to procure renewable energy is through an off-site corporate power purchase agreement (PPA). A PPA is where a contractor builds, owns and operates a renewable energy asset (e.g., a solar or wind turbine farm) and sells power to partner(s) for an agreed price under a long-term contract. Under this structure, the City would benefit from the renewable energy source while avoiding both upfront funding and ongoing maintenance responsibilities. Energy purchased via a PPA may be procured more cheaply than standard grid electricity. However, it risks locking in energy prices for the medium to long-term, which may not end up being favourable.

While PPAs are standard practice for large-scale renewable energy projects, PPAs signed with non-retailers such as councils and other organisations are relatively new within Australia, although they are growing in popularity.
Engagement program

The City aims for its staff to understand and seek to reduce the impact of their individual actions and corporate projects on energy consumption and carbon emissions. The City will evaluate and promote its progress and learnings internally and to the wider community.

Key challenges

- **Corporate policy and targets:** there is no policy or target to guide energy consumption and carbon emissions reductions
- **Corporate responsibility:** there is no defined cross-business-unit support network and responsibility pathway to drive and deliver carbon emissions reductions
- **Staff awareness:** there is limited awareness among officers as to how their business unit, assets and projects contribute to energy consumption, carbon emissions and climate change
- **Ongoing support:** there is no ongoing staff training and awareness program to build knowledge and to support real and ongoing behaviour change
- **Community awareness:** there is no ongoing community awareness program to build knowledge of the City’s corporate carbon-emissions-saving initiatives among the wider community.

Completed actions

- **Corporate planning:** included energy use and emissions in the Strategic Community Plan
- **Engagement:** developed staff ‘switch off’ campaigns for extended holiday closures, where business units compete to reduce energy use over a set period of time
- **Training:** included energy and emissions in staff induction e-learning module
- **Annual Report:** included energy consumption and carbon emissions data in the City of Stirling Annual Report since 2012
- **Carbon Inventory Report:** produced an annual Corporate Carbon Inventory Report since 2015.

Current actions

- **Corporate planning:** produce a Sustainable Energy Action Plan (Corporate) including a corporate carbon emissions target
- **Reporting:** continue to report on energy consumption and carbon emissions in the City of Stirling Annual Report.

New actions

- **Review Sustainability Policy:** to acknowledge climate change impacts and the City’s commitment to reducing carbon emissions
- **Sustainable energy steering group:** include a high-level project sponsor and relevant managers from across the business to meet quarterly and drive progress of the Sustainable Energy Action Plan (Corporate)
- **Budget planning:** submit a carbon reduction plan annually to the steering group as part of the operational and capital works budget process, to ensure the required annual cumulative carbon emissions reduction is achieved
- **Energy consumption and emissions report:** send biannually to relevant managers to raise awareness of energy consumption, cost and carbon emissions
- **Review project charter:** to ensure energy and emissions impacts and risks are adequately considered and mitigated at the project planning and design stage
- **Behaviour change campaign:** to provide training and raise awareness for staff and building users on how individual actions can reduce energy consumption, carbon emissions and climate change
- **Sustainable Energy Report:** include progress against Sustainable Energy Action Plan (Corporate) actions and detailed energy consumption and carbon emissions data
- **Cities Power Partnership (CPP):** demonstrate commitment to reducing carbon emissions by joining the CPP
- **Community awareness campaign:** to promote the City’s emissions reductions efforts, learnings and achievements.
Data and reporting program

The City aims to build a complete register of energy utility accounts and meters and the assets they service. Energy data should be managed in one central system, improving accuracy and access to data for strategic decision making and reporting.

Key challenges

- **Scale**: there are in excess of 400 electricity accounts and 70 natural gas accounts, making gathering and analysing data complex
- **Complexity**: there is a complex system of meters often with multiple assets running from one main meter. It is not always known (even by the energy provider) which meters power which assets
- **Disparate data sets**: there are numerous disparate energy data sets. They may not have the same details and are not synced so updates to one are not universal to all
- **Multiple data sets**: having multiple data sets means there is no one single source of information for planning, prioritising and evaluating energy use
- **Corporate process**: there are limited business processes to guide the capture, processing and reporting of data, leading to inconsistency across the business
- **Data exclusions**: data from tenanted or leased-out areas should be excluded as it is out of full operational control. However, this is not possible as not all tenanted or leased-out areas are adequately sub-metered
- **Data accuracy**: sub-meters at tenanted sites are read and the data collated manually. This increases the potential to introduce errors in both the reading and data-entry processes.

Completed actions

- **Energy data management**: procured an online system to manage historical and current energy and emissions data using invoices obtained directly from suppliers
- **Renewables data management**: used online portals to access half-hourly solar PV output data
- **Building data management**: used building management systems (BMS) and other online platforms to monitor real-time electricity and water use for priority buildings
- **Site mapping**: mapped 45 priority sites to determine which meters service which assets
- **Reserves data management**: developed report on energy use (kilowatt hours) for flooding and run time (minutes run) for irrigation from the centralised irrigation management systems (CIMS) in 2018
- **Data review**: completed city-wide utilities data review in 2017, detailing how data is managed and the improvements required to develop one single source of data.

Current actions

- **Online data management systems**: continue to use online systems to manage energy, emissions, renewables and building data
- **Site mapping project**: continue to map energy supplies at remaining complex and multi-use sites to improve understanding of energy consumption by individual assets.

New actions

- **Produce single data management system**: incorporate main meter, renewable energy and sub-meter data
- **Energy data management practice**: define business processes and responsibilities for data, including collection, verification, authorisation, change management and reporting
- **Sub-meters review**: produce a business case to install additional sub-meters, and potentially automatic meter readers, at tenanted sites to improve on-billing and exclusion of data in reporting
- **Smart-meters review**: determine feasibility, cost and business case to install automatic meter readers on main electricity supplies to improve data collection and monitoring.
Solar PV inverters and meters. The City monitors and reports on production of solar energy.
# Action plan and timeframe

This timeframe outlines the first four years of the plan, reflecting the rolling four-year program of works.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
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<td></td>
<td></td>
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<td>1.01 Complete 10 facility energy audits annually</td>
<td>Facilities, Projects and Assets (FPA)</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Number of completed audits</td>
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<tr>
<td>1.02 Produce rolling four-year program of works</td>
<td>FPA</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Number of planned and budgeted projects</td>
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<tr>
<td>1.03 Deliver energy efficiency projects – HVAC, BMS, lighting upgrade/renewal</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Number of completed projects</td>
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<td>1.04 Upgrade and replace irrigation pumps – rolling 25-year asset upgrade and renewal program</td>
<td>Parks and Sustainability</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Progress against program</td>
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<td>1.05 Install LED floodlights – nine-year plan</td>
<td>Parks and Sustainability</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Progress against program</td>
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<td>1.06 Install Ci Anywhere business software</td>
<td>Corporate Information Services</td>
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<td></td>
<td></td>
<td></td>
<td>Software installed and operational</td>
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<tr>
<td>1.07 Install follow-me printing</td>
<td>Corporate Information Services</td>
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<td></td>
<td></td>
<td></td>
<td>Software installed and operational</td>
</tr>
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<td>1.08 Produce thermal comfort guidelines</td>
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<td>Completed guidelines</td>
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<td>1.09 Develop environmentally sustainable design (ESD) standards and scorecard</td>
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<td>Completed standards and scorecard</td>
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<tr>
<td>1.10 Design and build energy-efficient showcase building</td>
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<td>Deliver at least one showcase building</td>
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<td>1.11 Complete irrigation upgrade review</td>
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<td>1.12 Complete irrigation and floodlighting control review</td>
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<tr>
<td>2.01 Produce rolling four-year program of works</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Number of planned and budgeted projects</td>
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<td>✓</td>
<td>✓</td>
<td>kWp of systems installed</td>
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<td>2.03 Complete renewable energy review</td>
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<td>Completed review</td>
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<tr>
<td>2.04 Complete renewable energy generation plan</td>
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<td>Completed review</td>
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<tr>
<td>2.05 Complete power purchase agreement tender process</td>
<td>Parks and Sustainability, FPA, Finance</td>
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<td>Procurement of PPA</td>
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<td>2.06 Develop environmentally sustainable design (ESD) standards</td>
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<td></td>
<td>Completed standards and scorecard</td>
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</tr>
<tr>
<td>2.07 Build net-zero-emissions showcase building</td>
<td>FPA</td>
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<td></td>
<td></td>
<td>✓</td>
<td>Deliver at least one showcase building</td>
</tr>
<tr>
<td>2.08 Complete battery storage trial</td>
<td>FPA</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Deliver at least one battery storage trial</td>
</tr>
</tbody>
</table>

**Engagement program**

| 3.01 Produce Sustainable Energy Action Plan (Corporate) | Parks and Sustainability | ✓ | | | | Completed plan |
| 3.02 Produce Annual Report | Parks and Sustainability | ✓ | ✓ | ✓ | ✓ | Completed report; includes carbon emissions |
| 3.03 Review Sustainability Policy | Parks and Sustainability | ✓ | | | | Updated policy |
| 3.04 Develop Sustainable Energy steering group | Parks and Sustainability | ✓ | ✓ | ✓ | ✓ | Number of meetings and attendance of participants |
| 3.05 Carbon reduction plan in budget planning | Parks and Sustainability and FPA | ✓ | ✓ | ✓ | ✓ | Completed budgets |
| 3.06 Produce biannual energy consumption and emissions report | Parks and Sustainability | ✓ | ✓ | ✓ | | Completed reports |
| 3.07 Review project charter | Parks and Sustainability | ✓ | | | | Updated project charter |
| 3.08 Develop behaviour change campaign | Parks and Sustainability and FPA | | ✓ | ✓ | | Number of events completed |
| 3.09 Produce Sustainable Energy Report | Parks and Sustainability | ✓ | ✓ | ✓ | ✓ | Completed report |
| 3.10 Commit to Cities Power Partnership | Parks and Sustainability | ✓ | ✓ | | | Confirmed membership |
| 3.11 Develop community awareness campaign | Parks and Sustainability and FPA | ✓ | ✓ | | | Number of communications published externally |

**Data and reporting program**

| 4.01 Use online data management system | Parks and Sustainability | ✓ | ✓ | ✓ | ✓ | Subscription to data management system |
| 4.02 Continue site mapping project | Parks and Sustainability and FPA | ✓ | ✓ | ✓ | ✓ | Number of sites with energy supplies mapped |
| 4.03 Produce single data management system | Steering group | ✓ | ✓ | ✓ | ✓ | Combine main meter and renewable energy data |
| | | | | | Combine main meter and sub-meter data |
| 4.04 Produce energy data management practice | Steering group | | | ✓ | | Completed management practice |
| 4.05 Complete sub-meters review | Steering group | ✓ | ✓ | | | Completed review |
| 4.06 Complete smart-meters review | Steering group | ✓ | ✓ | | | Completed review |
Measuring our progress and success

The City will monitor and report on, at least annually:

- Progress on actions in the Sustainable Energy Action Plan (Corporate)
- Energy consumption, carbon emissions and renewable energy production.

Success will be measured by the actions completed and a reduction in carbon emissions.

The Sustainable Energy Action Plan (Corporate) will be reviewed after three years to determine further actions to prioritise. The interim KPIs will be assessed in 2025 to ensure we are on track to achieving the 2030 targets.

Emissions intensity – grid-powered electricity

The grid intensity, or the amount of emissions produced by supplying electricity, for the South West Interconnected System (SWIS) used by the City of Stirling is currently 0.69 t CO₂-e per kilowatt hour.

The emissions intensity of the grid should decrease as a result of actions to achieve Australia’s carbon emissions reduction target, its renewable energy target and the rapid growth of the renewable energy industry. There is a high degree of uncertainty around this due to policy and technology uncertainty. The City will monitor grid intensity reductions and adjust carbon emission reduction expectations accordingly.
Irrigation consumes energy, but is essential to keep vegetation healthy and surfaces suitable for recreational users.
The City works to reduce its environmental impact; pool blankets save both energy and water and reduce running costs at aquatic centres.
Appendices
Appendix 1 – Inclusions and exclusions

Scope rationale

In 2015/16, the City produced the first annual internal Corporate Carbon Inventory Report that measured energy consumption, energy costs and carbon emissions in accordance with Greenhouse Gas Protocol. Greenhouse Gas Protocol is a global standardised framework to measure and manage greenhouse gas emissions in the public and private sector.

This Plan includes only corporate energy consumption, costs and emissions, ie, energy used in the delivery of City services by the City’s building facilities, parks and reserves, City-owned streetlights, fleet, and waste contractor vehicles.

It excludes energy and emissions from assets where the City does not have full operational control, such as Western Power streetlights, tenanted properties (where data can be excluded), and community energy and emissions. It also excludes business travel, waste treatment and disposal, refrigerants and material use as the City has not yet begun to measure embodied energy and emissions.

This plan excludes transmission and distribution (T&D) emissions. Although the City is responsible for these emissions by virtue of using energy, they are not included in this Plan as they are not under the direct control of the City, and reducing use of electricity, natural gas and fuel will automatically reduce T&D emissions.

Western Power streetlights

Western Power owns around 20,000, or 98 per cent, of the City’s streetlights. The City has a legal responsibility to provide and pay for the energy used in residential streetlights. As Western Power manages the run-time, installation, maintenance and replacement of streetlights, they are not considered to be operational assets for the City and are not included in the City’s energy consumption or emissions.

Western Power streetlights cost the City approximately $4.1 million per annum or 46 per cent of total energy costs. The tariff Western Power charges the City is not based on energy consumed in either kilowatt hours or run-time, but instead includes supply, maintenance and replacement costs. Switching to energy efficient lights, for example LEDs, will reduce energy consumption and significantly lower maintenance costs as an LED globe has a much longer life and therefore does not need to be replaced as often. However, there is no incentive for Western Power to reduce energy consumption and pass on cost savings due to this regulated, non-contestable tariff structure.

The only opportunity available for the City is to effect change via advocacy. The City is on a WALGA working group and seeks to advocate to replace inefficient streetlights with more efficient (eg, LED) varieties; develop a reduced tariff for LED lighting to reflect decreased energy and maintenance costs; and produce a business case for LED replacements, empowering the City to replace Western Power streetlights and recover costs via a reduced tariff.

Green power, carbon offsets and carbon sinks

Green power is renewable energy purchased from an energy retailer at a surcharge. The City previously purchased green power for its administration building for four years from 2007. It was decided to divert the additional spend to energy efficiency and renewable energy projects.

Carbon offsets are certificates created by projects that reduce or avoid emissions that would otherwise have occurred, or actively sequester carbon from the atmosphere into permanent ‘sinks’ such as forests and soils. One carbon credit is equal to one tonne of carbon dioxide equivalent avoided, reduced or sequestered. The City purchased carbon offsets for fleet carbon emissions for five years from 2005. Offsets cannot be used to achieve science-based targets, and therefore do not contribute to the City’s carbon emissions reduction target.

The City manages approximately 80,000 street trees and has an active program to plant 1 million trees and shrubs. The City produced an iTree report in 2016 which showed that the City’s street trees sequester 807 tonnes of carbon per year and store 25,180 tonnes of carbon. By 2040, the City will manage an estimated 201,000 street trees and it is estimated that these will sequester 3,920 tonnes of carbon per year and store 75,174 tonnes of carbon. Street trees cannot currently contribute to official offsets under the National Carbon Offset Standard and therefore do not contribute to the City’s carbon emissions reduction target.

Carbon stored and sequestered in City of Stirling street trees
### Scope of Sustainable Energy Action Plan (Corporate)

<table>
<thead>
<tr>
<th>Business area</th>
<th>Corporate</th>
<th>Community</th>
<th>Other organisation / business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building facilities owned and occupied by the City</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floodlighting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Park assets, eg, toilets and BBQs</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streetlights – City-owned</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streetlights – Western Power-owned</td>
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<td></td>
<td>✓</td>
</tr>
<tr>
<td>Fleet fuel including business and allowable private use</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste contractor fuel</td>
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<td></td>
<td>✓</td>
</tr>
<tr>
<td>Sole occupancy tenant</td>
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<td>✓</td>
</tr>
<tr>
<td>Combined occupancy eg, City, tenant and community use</td>
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<td></td>
<td>Non-City occupancy should sit here, but data cannot be excluded without extensive further metering</td>
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<td>Use of materials/services</td>
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<tr>
<td>Waste treatment and disposal</td>
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<td>Not currently measured – out of scope</td>
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<td>Business travel by rail or plane</td>
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<tr>
<td>A/C refrigeration</td>
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<tr>
<td>Transmission and distribution (T&amp;D)</td>
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<td></td>
<td>Indirect emissions – out of scope</td>
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### Appendix 2 – Projects completed to date

#### Energy conservation and efficiency program

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Project</th>
<th>Site name</th>
<th>Estimated annual carbon emissions reduction (t CO₂-e)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Stirling Leisure Centres – Terry Tyzack Aquatic Centre – Inglewood</td>
<td>10.5</td>
</tr>
<tr>
<td>2013/14</td>
<td>Lighting – LED and lighting motion sensors</td>
<td>Administration Centre – Karrinyup Civic Centre</td>
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<td>2013/14</td>
<td>Lighting – motion sensors</td>
<td>Stirling Leisure Centres – Terry Tyzack Aquatic Centre – Inglewood</td>
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<tr>
<td>2014/15</td>
<td>Lighting – LED</td>
<td>Scarborough Library – Operations Centre – Stirling Community Centres - Jim Satchell - Dianella</td>
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<td>2014/15</td>
<td>VSD – pool pumps</td>
<td>Stirling Leisure Centres – Leisurepark – Balga</td>
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<td>2014/15</td>
<td>HVAC – optimisation</td>
<td>Operations Centre – Mirrabooka Library</td>
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<td>Lighting – LED</td>
<td>Administration Centre – Stirling Food Services – Osborne Civic Centre – Inglewood</td>
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<td>Mirrabooka Civic Centre – Operations Centre</td>
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<td>Administration Centre</td>
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<td>HVAC controls optimisation</td>
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<td>2016/17</td>
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<td>2016/17</td>
<td>HVAC – upgrade</td>
<td>Inglewood Civic Centre</td>
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</table>

38
<table>
<thead>
<tr>
<th>Financial year</th>
<th>Project</th>
<th>Site name</th>
<th>Estimated annual carbon emissions reduction (t CO₂-e)</th>
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<tbody>
<tr>
<td>2017/18</td>
<td>HVAC – optimisation</td>
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<td>Dianella Library Services</td>
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<td>Mirrabooka Civic Centre</td>
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<td>2017/18</td>
<td>HVAC controls optimisation</td>
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<td>Lighting – LED</td>
<td>Inglewood Civic Centre</td>
<td>4.3</td>
</tr>
<tr>
<td>2018/19</td>
<td>Lighting – LED</td>
<td>Osborne Civic Centre</td>
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</tr>
<tr>
<td>2018/19</td>
<td>HVAC – optimisation</td>
<td>Stirling Community Centres (Balga work depot + Osborne Community Centre)</td>
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</tr>
<tr>
<td>2018/19</td>
<td>HVAC – optimisation</td>
<td>Libraries (Mirrabooka, Dianella and Inglewood)</td>
<td>14.9</td>
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</tbody>
</table>

**Renewable energy program**

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Project</th>
<th>Site name</th>
<th>Estimated Annual carbon emissions reduction (t CO₂-e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012/13</td>
<td>Solar – PV</td>
<td>Administration Centre (36 kWp)</td>
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<td>2012/13</td>
<td>Solar – black matting</td>
<td>Stirling Leisure Centres – Leisurepark – Balga</td>
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<td>2013/14</td>
<td>Solar – hot water systems</td>
<td>19 community facilities</td>
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<td>2014/15</td>
<td>Solar – PV</td>
<td>Stirling Community Centres - Scarborough (15 kWp) and Scarborough Library (15 kWp)</td>
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<td>2015/16</td>
<td>Solar – PV</td>
<td>Stirling Leisure Centres – Herb Graham Recreation Centre – Mirrabooka (40 kWp)</td>
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<td></td>
<td>Inglewood Library (15 kWp)</td>
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<td>Mirrabooka Library (15 kWp)</td>
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<tr>
<td>2017/18</td>
<td>Geothermal pool heating</td>
<td>Scarborough Beach Pool</td>
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<td>2017/18</td>
<td>Solar – PV</td>
<td>Stirling Leisure Centres – Hamersley (25 kWp)</td>
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<td>Administration Centre – extension (64 kWp)</td>
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<td>Operations Centre (92 kWp)</td>
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<td>Osborne Civic Centre (33 kWp)</td>
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<td>Solar – PV</td>
<td>Stirling Leisure Centres – Terry Tyzack Aquatic Centre – Inglewood – (200 kWp)</td>
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<td>2018/19</td>
<td>Solar – PV</td>
<td>Stirling Leisure Centres – Herb Graham Recreation Centre – Mirrabooka – extension (60 kWp)</td>
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</tbody>
</table>
Glossary

Gigajoules: a gigajoule (GJ) is a standard measure of energy use equal to one thousand million joules. Electricity is measured in kilowatt hours (kWh), natural gas in megajoules (MJ) and fuel in litres (L). These are all converted to GJ to standardise the measurement for energy use among the different energy sources.

Carbon emissions: there are several greenhouses gases that contribute to climate change, including methane, nitrous oxide and carbon dioxide. These endure in the atmosphere for different periods of time. The most common greenhouse gas is carbon dioxide and scientists often standardise these gases into ‘carbon dioxide equivalents’, commonly abbreviated to ‘carbon emissions’.

CO$_2$-e: denotes carbon dioxide equivalent emissions.

References

4. Seed Consulting Services, 2017. iTree Eco Assessment of the City of Stirling’s Tree Database. A report prepared for the City of Stirling, Western Australia.
The City's Main Administration Centre has a 100 kWp solar PV system on its roof which produces around 10% of the building's total electricity consumption.