Urban developments built now and into the future will have a lasting effect on the sustainability of our cities. Developing a strategic approach to the delivery of best practice sustainability measures, in design, technology and place creation, is critical in ensuring that projects can systematically address their environmental impact, and do so cost effectively.

The Moreland Energy Foundation Limited (MEFL) has developed a framework to guide this, linking a set of high level principles to the delivery of ‘on-the-ground’ opportunities and success indicators, through all stages of development from concept, masterplanning, detailed design, construction through to operation.

This is a document for anyone involved in the creation of new urban environments, from planners through to architects, and councillors to senior development proponents.

It is not intended to be a rating tool or a detailed design manual. It is also not exhaustive; sustainability in urban development is constantly evolving and it is expected that this document will do the same.

It is hoped that this framework can catalyse and assist in delivering high quality sustainability in urban development.

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**Disclaimer:**
This document has been developed by Moreland Energy Foundation as part of Moreland Solar City. The document represents MEFL’s views and does not necessarily reflect the views of the other Moreland Solar City Partners, unless expressly stated. Every effort has been made to ensure all information is true and accurate at time of publication.
Energy efficiency

Introduction

Energy efficiency is one of the most cost-effective ways of reducing greenhouse gas emissions, and can also be one of the easiest approaches to implement. It often involves relatively subtle changes in design, materials and the systems that are incorporated into a building, and in many cases have low cost impacts, particularly if these changes are made very early in the design process.

Energy efficiency concepts

Thermal performance refers to a building's ability to maintain a relatively stable internal temperature. Thermal performance is affected by many factors including building orientation, location and size of windows and eaves, use of natural ventilation, and construction materials, insulation and draught sealing.

Energy efficient appliances include both fixed and non-fixed devices such as lighting, white goods, heating and cooling systems. When considering the relative energy efficiency of one system compared to another it is important to also consider the carbon intensity of the fuel source (e.g. electricity versus natural gas).

Urban heat island effect occurs in urban areas when buildings, roads and non-natural forms absorb and retain heat. Heat islands can increase summertime peak energy demand, air conditioning costs, air pollution, greenhouse gas emissions and heat-related illness. Measures to reduce urban heat island effect include increasing vegetation and large scale green roofs and walls, and using light coloured cladding and finishes.

A green roof or wall's main purpose is to regulate internal building temperature by reducing heat retention and acting as insulation. They can also improve local air quality, enhance biodiversity, reduce the impact of storm water runoff, provide a relaxing space for residents and reduce the urban heat island effect.

Building management systems control the active systems within a multi-unit or commercial development to optimise management for energy efficiency.

Project context

The German city of Freiburg is home to a number of innovative sustainable development projects, including the district of Vauban. This suburb, home to around 5,000 people, has delivered best practice in a range of key principles of sustainable urban development, including building energy efficiency.

The planning provisions for the site require developers to meet very high thermal performance standards, and a large number of buildings have gone beyond this standard to achieve Passive Haus certification. This European standard means the building requires almost no active heating or cooling.

Careful site orientation, optimal glazing ratios and high performance materials enabled developers to achieve the required standards cost-effectively. Additionally, an innovative centralised car parking system meant that car spaces as part of individual buildings were not required, removing a significant construction cost to developers.

http://www.vauban.de/info/abstract.html

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
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</table>
| Maximise thermal performance                    | Six-star and seven-star houses require an average of 24% and 45% less heating and cooling respectively, when compared to a five-star rated house. | Early action: The greatest potential to maximise thermal performance is at the concept and design phase.  
Cost: Building efficiently can add to construction costs.  
Slightly smaller apartments, reduction in materials and improvement in construction efficiencies can offset this.  
Regardless, any additional upfront cost is generally outweighed by the ongoing cost savings from lower energy costs.  
Industry education: Supply chain training may be required to improve Insulation and draught sealing competencies to ensure buildings meet desired performance levels. | • Readily available energy efficiency design tools can optimise design as well as calculate energy star rating.  
• The marginal cost of exceeding regulatory requirements can be very low or even neutral if incorporated from early concept stages.  
• Additional costs can be recouped through a sustainability premium, on the basis that the cost savings over time justify the higher upfront investment.  
• Alternative ownership models such as owners collectives can overcome split incentive issues.  
• More efficient planning process, with mechanisms such as a ‘green door’ for sustainable buildings could reduce approval times and related land holding costs. |
| Use of energy efficient appliances in premises   | Fixed (including water heaters) and non-fixed appliances account for on average up to 40% of household energy use. | Cost: Additional up-front cost and split incentive.  
End user responsibility: Portable appliances, such as fridges and TV, are usually supplied by owner occupier or tenant, leaving the developer with little influence over these choices. | • Rising energy costs are likely to shorten payback period.  
• Well recognised and robust energy rating schemes exist, and high efficiency models are now widespread.  
• Potential for developers to work with retailers to offer incentives for owners and tenants to replace less efficient appliances. |
| Reducing urban heat island effect                | The urban heat island effect can increase localised temperatures by up to 7°C in urban areas. | Finding balance: The need for higher density development must be balanced against potential increases in heat island effects of increased density. | • No or low cost measures include using light coloured or reflective surface finishes that absorb less solar radiation.  
• Green roofs and walls have been found to have superior long term reduction of heat and improved thermal comfort compared to using materials or surfaces with lower solar absorption potential. |
| Green roofs and walls                           | Green roofs can reduce heat absorption by 10°C to 22°C.  
Can provide additional insulation to the building, reducing the impact of external temperature on occupant comfort. | Construction and cost impacts: May need greater structural support, which may incur additional cost, although this is less likely if incorporated from early in the design process.  
Maintenance: Ongoing maintenance and management is required. | • Portland (Oregon) and Chicago City Councils allows for increased density proportional to an increase in provision of of green roofs/ walls.  
• New York City Council provides a tax credit in the first year for building owners who install green roof over 50% of the roof area. |
| Building management systems (BMS)                | BMS that control lighting alone can save up to 70% of associated energy costs.  
Extends the operational life of equipment and systems through reduced loads and operating hours. | Cost: May incur additional upfront costs, although these are likely to be offset by ongoing cost savings through efficiency of operation.  
Target tracking: High quality data can verify achievement of targets and predicted savings. | • In larger commercial buildings energy performance contracts may allow upfront costs to be met by an external provider in return for a share of the ongoing cost savings.  
• Wireless systems allow for easy retrofit to existing buildings. |
Energy efficiency

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<tr>
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</table>
| **Energy efficient common area lighting** | Lighting for common areas often runs 24 hours a day, 365 days a year - even when most of the time no one is around. While each light may have relatively small energy needs, when run constantly this can add up to be a significant energy user. | **Getting it right the first time:** The payback period for installing energy efficient lighting upfront is much less than for retrofitting. | • Latest model lighting can provide better quality lighting and reduce energy use.  
• The number of lights and light levels may be rationalised based on technology selection, usage patterns and community views.  
• Local governments may be able to have some influence over technology selection using planning approvals.  
• Solar powered street lights can last up to five times longer than standard lamps reducing ongoing maintenance costs.  
• Solar powered street lights are being implemented by local councils in new developments throughout Australia. |

**Current practice**

Minimum new build energy efficiency standard

**Current practice:**

| Aurora (Melbourne, Australia, 2008-2025) | 6 star. |
| WestWyck (Melbourne, Australia, 2008) | 8.5 star. |
| Vauban (Freiburg, Germany, 2008) | 10 star. |

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<td>New residential building energy efficiency standard (FirstRate equivalent)</td>
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**Implementation time frame**

- **Concept**
  - Define goals and targets for energy efficiency.
- **Masterplanning**
  - Consider orientation and solar access in layout.
  - Consider urban heat island impacts of building massing and landscape design.
- **Design**
  - Consider structural needs of green roofs and walls.
  - Embed best practice energy efficiency in clear and robust design brief.
  - Fixed appliances specified to meet best practice.
- **Construct**
  - Supply chain education critical in ensuring standards are delivered and construction materials and techniques are not unfairly ‘risk priced’.
- **Operate**
  - Incentivise high efficiency appliances.
  - Ongoing information and education to support behaviour change.
  - Maintenance of green roofs/walls and appliances required.
On-site energy generation

Introduction

The vast majority of Victoria’s electricity generation facilities are located a significant distance from the end point of use. This centralised electricity system sees up to 70% of the fuel’s potential energy lost during generation, transmission to urban areas and distribution within towns and cities.

On-site energy generation can reduce transmission losses by being located close to the final point of electricity use. Additionally, on-site generation that uses low-carbon or renewable resources can significantly reduce the greenhouse gas emissions associated with fossil fuel-based generation.

On-site energy generation concepts

**Solar water heating systems** use solar radiation to heat water. When there is insufficient solar radiation systems have either gas or electric boosters to heat water.

**Photovoltaic (PV) panels** convert solar radiation into electricity without producing any emissions. PV panels are long lasting and require very little ongoing maintenance.

**Wind power** is the use of wind to turn a turbine that generates electricity. Micro wind turbines are small rooftop mounted wind turbines suitable for use in urban areas.

**Waste to energy** is the process of creating electricity or heat from waste. Biological or thermal processes are used to break down the waste, leading to significant potential emission reductions.

**Cogeneration**, or combined heat and power (CHP), is the recovery and use of heat created as a by-product of electricity generation to provide another energy service. This waste heat can be used to heat water or air or to create steam.

**Tri-generation** converts the waste heat from cogeneration into coolth using absorption chilling.

**Micro-grids** are private energy networks that support single or multiple buildings on one or more sites and can be supplied by one or more on-site energy generation systems.

**Embedded networks** enable the private distribution and sale of energy within a building.

Case study

Dockside Green, a leading sustainable precinct development in Victoria, Canada, demonstrates how a range of the onsite generation opportunities present in many mixed-use developments can be implemented.

The project has delivered a range of innovative onsite energy generation measures, the most significant of which is a biomass fuelled district heating system, which provides all the heating and hot water requirements of the 6 hectare site. This system also captures the waste heat from the site’s blackwater treatment plant, and has begun to export surplus heat to surrounding properties to provide additional revenue.

The plant is operated by a purpose created energy services company Dockside Green Energy, which is responsible for maintenance, customer connections and billing.
<table>
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<tr>
<th>Opportunity</th>
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<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
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<tbody>
<tr>
<td><strong>Solar water heating</strong></td>
<td>Water heating accounts for approximately 20% of energy use in both the residential and the commercial sectors.</td>
<td><strong>Physical constraints:</strong> Availability of suitable roof-space and correct orientation are vital to an efficient system. <strong>Administration:</strong> The shared ownership arrangements of roof-space in multi-apartment buildings can complicate administration of infrastructure installed on this space.</td>
<td>• As solar hot water systems have become a part of minimum regulatory compliance, system costs have been absorbed into normal construction costs. • For multi-apartment buildings solar water heating systems can be owned by the Owners Corporation, with individual units charged on hot water usage basis.</td>
</tr>
<tr>
<td><strong>Photovoltaic (PV) panels</strong></td>
<td>Peak solar radiation occurs in summer during the afternoon, which often coincides with peak electricity demand. Increased use of PV reduces the need for upgraded grid infrastructure and associated upward pressure on electricity prices.</td>
<td><strong>Cost:</strong> Upfront cost and ability of developer to recoup this through sale of dwellings. Large scale developments may encounter electricity grid connection and administrative issues. <strong>Physical constraints:</strong> Varying solar radiation throughout the year and roof space usually prevents generation of 100% of electricity requirements from onsite solar. <strong>Administration:</strong> Ownership of common property roof space presents similar issues to solar hot water. Access to incentives, such as feed-in tariffs, can also be influenced by system size and ownership.</td>
<td>• Developers could increase sale prices for dwellings to recover upfront cost by providing information on the reduced electricity costs and period in which purchaser will recoup this additional cost, which may be further reduced by providing ability to charge electric vehicles. • Alternatively, energy services company (ESCo) business models could be used to remove need for upfront capital and address grid connection and administrative issues. • An ESCo could also coordinate a ‘solar aggregation’ project, allowing residents and businesses without adequate roof-space to invest in an aggregated PV installation on a suitable building. • For multi-apartment buildings PV systems could be owned by the Owners Corporation with any income from feed-in-tariffs reducing annual fees.</td>
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<tr>
<td><strong>Micro wind turbines</strong></td>
<td>Reduced emissions associated with on-site electricity usage. Implemented by ANZ and Grollo as part of carbon neutral plans.</td>
<td><strong>Cost:</strong> High upfront capital cost. Ongoing maintenance required. <strong>Technical:</strong> Available wind energy is extremely site specific hence needs to be assessed for each individual development.</td>
<td>• Sustainability Victoria and the Alternative Technology Association provide comprehensive guides for micro wind turbine use in urban areas.</td>
</tr>
<tr>
<td><strong>Waste to Energy</strong></td>
<td>Greenhouse gas missions from waste decomposition comprise mainly of methane which can be used to generate electricity.</td>
<td><strong>Cost:</strong> Potentially high upfront capital cost. <strong>Technical:</strong> Stable and adequate demand for electricity and heat produced required. Requires an adequate and suitable waste stream. <strong>Social impact:</strong> Amenity issues and need to comply with relevant health and safety regulations.</td>
<td>• Onsite food waste could be suitable free fuel supply. • A waste to energy plant may benefit from co-location with a end user of its other by-products, which could include high quality fertiliser. A community garden or urban greenhouse could be suitable.</td>
</tr>
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</table>
## Biomass Boilers

- **Opportunity:** Can significantly reduce the greenhouse intensity of space heating and hot water provision.
- **Potential Impact:** Reduced waste collection costs and associated transport emissions (if using fuel sourced onsite).
- **Challenges and Considerations:** Replacing fossil fuel with wood fuel (combusted efficiently) can reduce net CO₂ emissions by up to 90%.
- **Technical:** Requires a reliable, local supply of biomass. Ongoing regular maintenance required.
- **Regulatory:** Emissions must comply with relevant regulations.
- **Context:** Fuel cost savings are greatest where biomass boilers replace electric heating systems.
- **Innovations and Solutions:**
  - ESCo business models could be used.
  - Reliable technology - small boilers (less than 5 MW) using fuels such as wood pellets, straw and municipal solid waste have been used in many countries for a long time. Allows for on demand heat generation. Onsite green waste could be suitable as a free fuel supply as per BedZED and Dockside Green developments.

## Cogeneration and Tri-generation

- **Opportunity:** Gas-fired cogeneration can reduce CO₂ emissions by 53% compared with Victorian grid electricity.
- **Potential Impact:** Tri-generation can provide significant emission reductions in the Victorian commercial sector as space heating and cooling contribute to over 25% of energy usage.
- **Challenges and Considerations:**
  - Initial grid contains only one generation unit that supports two buildings saving 1000 tonnes of CO₂ each year. By 2030 the network aims to cover 70% of the city’s buildings.
  - Technical: Stable and adequate demand for electricity and heat produced, with long term certainty.
  - Cost: High upfront capital investment.
  - Regulatory: ESCos require long term energy supply contracts in order for systems to be financially viable.
  - Regulatory: Lack of support in the form of feed-in tariffs or reduced network charges.
  - Regulatory: Multiple regulatory issues associated with retail contestability and distribution and connection to grid etc.
  - Technical: Requires a reliable, local supply of biomass. Ongoing regular maintenance required.
  - Regulatory: Emissions must comply with relevant regulations.
  - Context: Fuel cost savings are greatest where biomass boilers replace electric heating systems.
- **Innovations and Solutions:**
  - ESCos have been used by numerous projects to deliver such systems.
  - Systems shared by multiple buildings can improve stability of heat and electrical demands, especially for mixed-use developments.
  - Systems have been successfully implemented for many aquatic centres due to a relatively high and stable heat demand.
  - Many systems can be turned on/off and ramped up/down quickly to respond to load variations or to operate only during peak electricity pricing periods.
  - Can ensure continued supply during grid failures, providing a potential point of difference and additionally security for critical supply needs.
  - May provide a competitive sales advantage due to the commercial building mandatory energy rating disclosure required for rental and resale.

### Current Practice

#### Proportion of energy that is sourced from renewable or low carbon sources

<table>
<thead>
<tr>
<th>Proportion</th>
<th>Average Victorian residential apartment development (2010) 3%</th>
<th>Vauxan (Freiburg, Germany, 2006, mixed use) 66%</th>
<th>One Brighton (UK, 2009, residential) 57%</th>
<th>Malmo, (Sweden, 2003, residential) 100%</th>
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</thead>
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<tr>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
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<tr>
<td>50%</td>
<td>60%</td>
<td>70%</td>
<td>80%</td>
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<tr>
<td>100%</td>
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</table>

### Implementation Time Frame

- **Concept**
  - Determine “ambition” regarding local energy generation.
  - Predicted energy needs modeling.
  - Consider solar orientation for onsite solar energy generation.
  - Infrastructure planning for heating/cooling distribution infrastructure.
  - Scoping of governance structure to enable delivery.
- **Masterplanning**
  - Detailed technical feasibility analyses.
  - Roof orientation, space and load bearing capacity considered for onsite solar energy generation.
  - Design to permit infrastructure associated with cogeneration.
  - Delivery vehicle established.
- **Design**
  - Delivery and connection of distribution infrastructure for heating and cooling from trigeneration.
  - Grid connection of onsite generators.
- **Construct**
  - Maintenance and support for onsite generation infrastructure.
  - Customer interface providing billing and information services.
- **Operate**
**Introduction**

It is often not practical or cost-efficient for developments to attempt to achieve ‘zero carbon’ or ‘carbon neutrality’ via on-site actions only. A range of issues mean that some energy needs and residual emissions are better addressed through other mechanisms.

Critical in this is ensuring that the environmental credentials of any offsite mechanisms are carefully verified, to ensure the development can be confident in any claims made. This section describes two actions that can be taken in order to address any residual emissions.

**Key concepts for residual emissions**

**Off-site energy generation** is the production of energy using renewable or low-carbon resources at a site other than the main development.

**GreenPower** is a government-accredited scheme for electricity generated from renewable sources. Purchasing GreenPower ensures the equivalent percentage of annual electricity consumption is sourced from zero net emission sources.

**Carbon offset** programs invest in measures that compensate for emissions such as renewable energy generation, energy efficiency, methane reduction and forestry. Developments promoting themselves as ‘zero carbon’ or ‘carbon neutral’ need to consider independently certified or accredited offsets.

**Case study**

The Western Harbour urban renewal district in Malmo, Sweden, was developed under a set of ambitious targets for sustainability across energy, water, waste and transport. The project, developed on remediated industrial land, incorporated a range of features to reduce its carbon footprint and energy consumption as much as possible, as well as incorporating some onsite energy generation through solar panels and solar hot water.

A commitment to 100% renewable electricity meant that the remaining electricity needs for the site had to be met by another sustainable source, and the project partners ultimately commissioned a 2MW wind turbine on a separate site nearby. This renewable energy generator was financed and built as a direct result of the project, meaning that the site’s claims of 100% renewable energy are extremely robust.

http://www.malmo.se/sustainablecity
### Opportunities for closing the gap

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Off-site energy generation</strong></td>
<td>Off-site energy can be scaled to meet all of the electricity needs of the development, potentially eliminating some or all of the emissions associated with electricity use.</td>
<td><strong>Cost:</strong> High upfront capital costs and ‘split incentive’ issue. Cost premium compared to traditional electricity. <strong>Technical:</strong> Securing an appropriate site. <strong>Regulatory:</strong> Approvals and regulatory issues (e.g. network connection). Infrastructure timing may not coincide with development. Ensuring ‘additionality’.</td>
<td>• Projects such as the Hepburn Community Wind Farm have demonstrated the potential of community investment models. • ESCo could be used. • Purchase of land/dwelling in development could come with shares, proportional to value. • Purchase of land/dwelling in development could be bundled with shares in a community owned renewable energy generator.</td>
</tr>
<tr>
<td><strong>GreenPower</strong></td>
<td>Encourages investment in new renewable energy sources which helps to lower the overall emissions intensity of grid electricity. Purchasing 100% accredited GreenPower would save an average Australian home approximately 7 tonnes of emissions per year, equivalent to removing almost two cars from the road.</td>
<td><strong>Cost:</strong> GreenPower does pose an additional cost to customers. <strong>Uptake:</strong> Owners/tenants are free to choose their own electricity retailers and products hence purchase of GreenPower may need to be incentivised.</td>
<td>• Bulk purchase of GreenPower may be possible. While individual apartments and commercial tenants would be metered individually, electricity consumption could be billed by the owners corporation or an embedded network operator rather than a retailer. This ‘bulk purchase’ approach could reduce the cost premium of GreenPower to residents.</td>
</tr>
<tr>
<td><strong>Carbon offsetting</strong></td>
<td>Can compensate for all emissions associated with a specific activity or all aspects of the development and the lifestyle of its residents. Carbon offsets can also support important initiatives including tree planting, renewable energy generation and large-scale energy efficiency programs.</td>
<td><strong>Administration:</strong> Periodic emissions calculations would be required to allocate the cost of carbon offsets across residents on an equitable basis. Concerns exist with the integrity of some offsets marketed, and confirming the integrity of these can be difficult.</td>
<td>• A commitment to carbon offsetting in owners corporation regulations could create a financial incentive to reduce energy consumption and overall emissions, as this would reduce the emissions needing to be offset.</td>
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</table>

### Implementation time frame

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Concept</strong></td>
<td>Define commitment to zero emissions and communicate this to stakeholders including prospective purchasers.</td>
</tr>
<tr>
<td><strong>Masterplanning</strong></td>
<td>Governance arrangements for owners corporation or ESCo. Scoping of potential off site projects and delivery mechanisms.</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>For off-site generation only: Feasibility study; Investment strategy; Special Purpose Vehicle (SPV) or ESCo created.</td>
</tr>
<tr>
<td><strong>Construct</strong></td>
<td>Owners corporation design and operating guidelines to allow bulk purchase of GreenPower for residents.</td>
</tr>
<tr>
<td><strong>Operate</strong></td>
<td>Administration of measuring and funding carbon offsets.</td>
</tr>
</tbody>
</table>
Introduction

Over 75% of waste generated during demolition and construction is clean excavated material, concrete, bricks and timber which are all highly recyclable. Reduction of construction waste is an opportunity to significantly increase resource efficiency and reduce project costs.

Demolition and construction concepts

**Design for sustainability** in this context includes actions such as designing for longevity and deconstruction, designing to standard material sizes to avoid excess and incorporating recycled and recyclable materials.

**Optimum value engineering** and advanced framing techniques may result in lower material and labour costs and improved energy performance for the building. The technique can be applied as a package or its components can be used independently, depending on the specific needs of the project.

**Waste management plans** for demolition and construction contractors include targets for resource recovery, identification of the destination of material types, and reused and recycled materials quotas.

**Prefabricated modular construction** occurs in a factory, rather than on site. More efficient use of materials and standard sizing can be achieved by constructing a housing unit using a factory manufacturing process.

Case study

VicUrban’s mixed use development ‘The Nicholson’, located in Melbourne’s inner-north, has utilised an innovative modular construction system in tandem with traditional construction techniques. This innovative modular construction method has a number of advantages over more traditional construction methods including the speed of delivery, higher quality control over apartment fit out and occupational health and safety benefits during the construction process with, for example, workers exposed less often to working at heights.

It has also helped the project to improve the thermal performance of the building, reduce material wastage and reduce the reliance on materials with high embodied energy. By constructing the units in a factory environment, material dimensions can be more easily standardised and greater precision ensures fewer components are damaged or wasted during assembly.

http://www.vicurban.com/thenicholson

http://unitisedarchipad.com/the-nicholson/

Image: Moreland construction site.
## Opportunities in demolition and construction

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<thead>
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<tbody>
<tr>
<td><strong>Design for sustainability</strong></td>
<td>Reduced material and waste disposal costs. 80% of environmental impacts are locked in at the design stage - it represents the key opportunity for change.</td>
<td><strong>Cost and skills:</strong> Additional time and expertise may be required at the design stage.</td>
<td>• Additional costs at the design stage may be offset by reduced material costs.</td>
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<td></td>
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<td>• Design firms increasingly view design for sustainability as an inherent part of their role.</td>
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<tr>
<td><strong>Waste management plans</strong></td>
<td>Recycling and reusing materials reduces cost of materials, landfill disposal costs and can even generate revenue. On average material waste accounts for 10% of total project construction costs.</td>
<td><strong>Skills:</strong> Contractors and subcontractors can be required to participate in a waste minimisation program as a condition of their contract.</td>
<td>• Minimal cost impact as is now common practice and the market for recycled materials is strong.</td>
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<td>• Recycling and reusing materials reduces cost of materials, landfill disposal costs and can even generate revenue.</td>
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<td>• Sustainability Victoria publishes standard guidelines and contract clauses that can be inserted into formal agreements.</td>
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<tr>
<td><strong>Optimum value engineering and advanced framing techniques</strong></td>
<td>Houses in the USA have saved up to 50% on material and labour costs and reduced operational energy consumption by 25%.</td>
<td><strong>Cost and skills:</strong> Additional time and expertise may be required at the design stage. Framing crews may need special training.</td>
<td>• Can reduce materials and labour used in the framing process without sacrificing structural integrity.</td>
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<td></td>
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<td>• Can allow greater space for insulation in structural support walls.</td>
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<tr>
<td><strong>Prefabricated modular construction</strong></td>
<td>Use of prefabricated products can reduce waste and disposal costs by up to 50%.</td>
<td><strong>Cost:</strong> Additional time and expertise may be required at the design stage. <strong>Design:</strong> can require innovative approaches to design to achieve interesting aesthetic outcome.</td>
<td>• Off-site construction can facilitate separation and storage of waste streams.</td>
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<td>• Ability to combine modular and traditional construction allows flexibility in design and space utilisation.</td>
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<td>• Workplace safety is enhanced by eliminating excess materials and stockpiles of waste, and reducing the need for working at height on building sites.</td>
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<td>• Reduced holding costs as building and sitework can be completed simultaneously.</td>
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<td>• Can reduce time on site and the associated costs, such as crane hire, security and temporary fencing.</td>
</tr>
</tbody>
</table>
Demolition and construction

Current practice

Construction and demolition waste (by weight) recycled or reused

Current practice:

<table>
<thead>
<tr>
<th>Low</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
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<td>71%</td>
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</table>

Construction and demolition waste (by weight) recycled or reused

Implementation time frame

Concept

Establish waste reduction, recycling and reuse targets.

Masterplanning

Consider opportunities to utilise modular construction. Consider design for sustainability and deconstruction.

Design

Incorporate design for sustainability and deconstruction into design brief. Establish waste management plan. Innovative construction technologies incorporated into design approach.

Construct

Waste management plan for construction contracts implemented and monitored.

Operate

Ensure future works and maintenance are guided by sustainable material selection policy.
Introduction

The household sector in Australia generates almost 12 million tonnes of solid waste every year, and only 38% of this waste is recycled. Over one third of household waste is organic including, food and garden waste. When organic material breaks down in landfill methane emissions are released which account for 3% to 4% of Australia's greenhouse gas emissions. Diverting food waste away from landfill reduces greenhouse emissions and can create valuable resources, such as compost.

Waste avoidance

Waste management infrastructure refers to the inclusion of facilities that enable good waste separation and management. Examples include providing space in apartments for multiple bins, providing separate garbage and recycling chutes in high density buildings and providing communal storage areas for recyclable materials that are not collected through kerbside services (e.g. batteries, e-waste and light globes).

Differential pricing involves charging households and businesses per unit of waste they dispose of to landfill, incentivising waste avoidance, recycling and composting.

Small scale resource recovery includes composting hubs or worm farms for the onsite treatment of organic materials such as kitchen scraps.

Large scale resource recovery includes either on or offsite facilities to process either the organic component of household garbage or the entire waste stream.

Non-standard recycling services can be introduced for products or materials that are not recyclable through the kerbside collection service, such as batteries and household appliances. The need for these services should be determined with reference to the recycling services provided by local councils via hard waste collections and at resource recovery centres.

Product sharing involves households and businesses sharing infrequently used items, such as tools or appliances. Environmental benefits arise from reducing the amount of goods that each household needs to purchase, and ultimately dispose of. This can be undertaken through formal schemes such as The Sharehood, or informally between neighbours.

Goods libraries are membership-based loan services for infrequently used items such as tools.

Case study

Hammarby, a major urban regeneration project delivered close to Stockholm's city centre in Sweden, took a highly innovative approach to waste management at the site. To satisfy a series of goals around waste management, including improved waste stream separation, reduced greenhouse emissions through efficient waste collection and improved amenity through reducing vehicle movements and odours, the project installed a highly efficient “Envac” automated waste management system.

Using a network of underground pipes connected to fixed waste disposal points in public places and adjacent to apartment buildings, the system uses vacuum to suck waste to collection points for transfer to recycling facilities and landfill. The system has been shown to significantly improve the separation of recyclable materials and has ensured the precinct is not subject to a weekly “invasion” by a fleet of garbage trucks.

http://www.hammarbysjostad.se/

Image: Waste management infrastructure at One Brighton, UK.
## Opportunities for waste avoidance and recycling

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste management plans</strong></td>
<td>The NSW government identified that efficient waste management can save offices tens of thousands of dollars per year.</td>
<td><strong>Cost and skill:</strong> Additional time and expertise may be required at the design stage.</td>
<td>• Recycling materials reduces landfill disposal costs and can even generate revenue.</td>
</tr>
<tr>
<td><strong>Waste management infrastructure</strong></td>
<td>Convenient infrastructure can significantly increase in percentage of waste that is recycled, and the quality of waste separation.</td>
<td><strong>Physical constraints:</strong> Additional waste management infrastructure may marginally reduce land or floor area available for higher value uses. Adequate access for waste collection vehicles.</td>
<td>• Communal waste storage and collection areas can reduce the amount of space required for waste storage in each dwelling.</td>
</tr>
<tr>
<td><strong>Onsite small scale resource recovery</strong></td>
<td>Reduces fuel consumption and greenhouse gas emissions associated with the collection of waste. Resource recovery of the food component can reduce waste disposed to landfill by approximately 40%.</td>
<td><strong>Maintenance:</strong> Requires ongoing management and maintenance. <strong>Education:</strong> Requires education to ensure correct usage and minimise contamination.</td>
<td>• Costs can be offset by reduced kerbside waste collection costs. Can be combined with gardens and recreation space. Fertiliser products can be sold to generate revenue to offset any costs.</td>
</tr>
<tr>
<td><strong>Large scale onsite resource recovery</strong></td>
<td>Large scale onsite resource recovery can reduce waste to landfill by as much as 70%. Every kg of food waste sent to landfill generates about one kg of Greenhouse gas emissions.</td>
<td><strong>Cost:</strong> Generally more expensive per tonne of waste than landfill disposal. <strong>Regulatory:</strong> Planning and licensing conditions apply. <strong>Social impacts:</strong> Community concerns about proximity and amenity issues. <strong>Technical:</strong> Generally require significant quantities of waste to be financially viable. <strong>Technical:</strong> May be more appropriate where energy generated can be used on site.</td>
<td>• Waste could be sourced from outside the development to gain the quantities of waste required for financial viability. Long term waste supply contracts can reduce the risk of upfront investment. Systems exist that have generic approval by EPA Victoria thus only local planning approval is required.</td>
</tr>
<tr>
<td><strong>Offsite resource recovery</strong></td>
<td>Large scale offsite resource recovery can reduce waste to landfill by between 70% and 100%.</td>
<td><strong>Cost:</strong> Generally more expensive per tonne of waste than landfill disposal. <strong>Regulatory:</strong> Contractual commitments of the local government may prohibit alternative waste management arrangements. <strong>Education:</strong> Would need to be supported by an education campaign.</td>
<td>• Using a specialist service provider can avoid upfront capital costs and associated risks. Compostable nappy delivery and collection service now available in Melbourne. Local governments in Melbourne are trialing the collection of food waste as part of the standard weekly garden waste collection service.</td>
</tr>
<tr>
<td><strong>Non-standard recycling services</strong></td>
<td>Can reduce incidence of large items such as TVs from being abandoned on kerbside.</td>
<td><strong>Physical constraints:</strong> Adequate onsite space can be challenging, particularly in higher density developments.</td>
<td>• Could be delivered via owners corporations, or small community enterprises on a not-for-profit basis. Developers could collaborate with local councils to organise regular collection of non-standard recyclables.</td>
</tr>
</tbody>
</table>
## Waste avoidance and recycling

<table>
<thead>
<tr>
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<th>Innovations and solutions</th>
</tr>
</thead>
</table>
| **Product sharing and goods libraries** | Reduces the need to purchase items for ‘one-off’ or irregular use, and can foster community interaction. | Administration: Requires some sort of structure to link individuals to products.               | • An owners corporation or place manager could utilise a ‘community web portal’ to allow products listed and potential users to be ‘matched’.  
• Alternatively, sharing could be encouraged by linking neighbours via existing web sites like Sharehood. |
| **Differential pricing**              | Reduced collection frequency for non-organic material could result in improved amenity issues such as reduced vehicle traffic. | End user satisfaction: Applying different pricing mechanisms within the development to surrounding areas may create household discon tent. | • Where bins are communal overall reduction in bin quantity and size may reduce owners corporation fees, through reduced waste collection charges. |
| **Public place recycling**           | Creates public awareness and participation in sustainable resource use actions. Contributes to increased proportion of waste being recycled. | **Context:** Practise already in place by most municipalities in parks and strip shopping areas. **Context:** Waste is the highest expenditure area for Victorian local governments across all environmental issues, with $248.4 million spent in 2002-03. | • Can reduce council litter management costs. Clear guidance available on an effective and economic system.  
• Developers can collaborate with local councils to ensure new public places are designed with effective waste management in mind. |

### Current practice

**Reduction of waste to landfill**

<table>
<thead>
<tr>
<th>Current practice:</th>
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</thead>
<tbody>
<tr>
<td>Wikke (Helsinki, Finland, 2004, mixed use), 20%</td>
</tr>
<tr>
<td>BCS Maranoa Retirement Villages (Alstonville and Lismore, NSW, 2005, residential), 25%</td>
</tr>
<tr>
<td>Hammarby (Stockholm, Sweden, 2010, mixed use), 90%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction of waste to landfill during operation</th>
</tr>
</thead>
</table>

### Implementation time frame

- **Concept**
  - Establish post construction waste reduction, composting, recycling and reuse targets.
- **Masterplanning**
  - Land or floor area allocated for on site waste management infrastructure. Business case for waste management infrastructure determined.
- **Design**
  - Floor area allocated within premises for waste management requirements.
- **Construct**
  - Waste management infrastructure delivered. Precinct scale systems constructed to allow for connection of future development stages.
- **Operate**
  - Ongoing maintenance and management of infrastructure and services.
Reducing the need to travel

Introduction
Many daily travel needs are created by the separation of residential areas from land uses that support jobs, shops, key services, schools and recreation. By creating areas that support multiple uses, or locating new residential development close to existing services and infrastructure, the need to travel can be reduced significantly.

Key concepts
- **Mixed use developments** are those that combine residential, commercial, recreational and/or community amenities in close proximity.
- **Small office or home office** residences offer both residential and office amenities such that people may work where they live, including the ability to meet with clients.
- **Recreational facilities** include parks, barbeques, gyms, pools and tennis courts.
- **Key services** include offices, shops and cinemas, postal, banking, medical and childcare services.
- **Communal facilities** can comprise of a combination of recreational and commercial amenities that are available for use by residents and businesses in the development. Depending on the scale of the development these could include meeting rooms, function areas, lecture theatres etc.
- **Business service providers** are private organisations that rent out meeting spaces and offices, as well as providing reception and telecommunications facilities to businesses.

Case study
Melbourne’s hierarchy of Activity Centres is based on identifying key precincts that contain a mix of particular uses and community facilities. ‘Principal Activity Centres’ and ‘Central Activities Districts’, such as Dandenong, Footscray and Coburg, are places which can support significant employment, residential development, key community services and are serviced by good transport services. They also represent the ability to establish areas where the need for travel between work, home and recreation is reduced.

The Coburg Initiative, the major urban renewal project at Coburg Principal Activity Centre, will create an environment suited to ‘5 minute living’, where key daily needs are within an easy 5 minute walk. By combining higher density residential development with key community services, diverse retail and commercial uses, a pedestrian-focused environment and communications infrastructure such as high speed broadband, the precinct will present opportunities for many residents to work, live and play without significant travel.

thecoburginitiative.com/

Image: Vibrant mixed-use streetscape.
Reducing the need to travel

Opportunities for reducing the need to travel

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
</table>
| **Mixed use development**         | Trips related to work, shopping, personal business and recreation comprise over 70% of total trips made in Melbourne. Locating houses and apartments close to jobs, shops and recreation can significantly reduce this need to travel. A mixture of uses can foster a sense of community and collaboration. | **End user needs:** It can be challenging to balance the needs of residential, business and community uses in close proximity. | • A vibrant and diverse mix of uses is often highly sought after by commercial and residential purchasers and tenants, thus providing a potential price premium.  
• Innovative approaches to planning regulation can require mixture of use and specify delivery through urban design guidelines.  
• Some car parking could be managed to provide for either residents or visitors (shoppers or workers), reducing total parking requirements.  
• Alternate parking management strategies may generate an ongoing revenue, which could be used to fund alternative transport such as public transport tickets, bike parking facilities or infrastructure upgrades. |
| **Recreational and communal facilities** | Trips related to recreation comprises 25% of total trips made in Melbourne. | **Physical constraints:** Inner-city sites can be restricted in their ability to include recreational facilities, in particular open space.  
**Cost:** Additional facilities as part of a development’s common area are likely to have a cost implication. | • Business models could include charging rent for the use of the space or incorporating additional cost into body corporate fees.  
• Commercial operators e.g. catering and business services providers can be engaged to manage these facilities.  
• Effective provision of communal facilities can provide a point of difference for a development, attracting buyers looking for home office facilities.  
• In some cases may allow for individual apartments to be reduced in size, reducing construction costs. |

**Current practice**

Percentage of trips less than 6km

<table>
<thead>
<tr>
<th>Percentage of trips less than 6km</th>
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<tbody>
<tr>
<td>Current practice:</td>
</tr>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Moderate</td>
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<tr>
<td>High</td>
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</table>

**Implementation time frame**

- **Concept**
  - Diverse range of uses embedded in development concept, capitalising on local strengths and needs.
- **Masterplanning**
  - Land or floor area designated to uses. Consideration of vehicle traffic management and parking, reducing impact on pedestrian and cycle traffic.
- **Design**
  - Consideration given to potential for apartments to be used as home offices. Flexible communal facilities integrated into design.
- **Construct**
  - Concepts of local or ‘5 minute’ living incorporated into marketing strategy.
- **Operate**
  - Ongoing management and maintenance of communal facilities. Local ‘place identity’ supported to ensure vibrant and successful business mix and service provision.
Reducing private vehicle use

Introduction
Cars now dominate most Australian cities. While they can provide valuable mobility for some needs, they can also reduce the quality of life in our cities, and the ability to get around using other means. For many daily transport needs, cars are not the best option.

Reducing private vehicle use has many benefits including financial savings for individuals, reduced congestion, reduced noise pollution, reduction in required parking spaces, increased safety and reduced greenhouse emissions.

Key concepts

- New public transport infrastructure may be delivered as part of large development projects. This could include adding new stops or interchanges to an existing route or establishing a new train, tram or bus route.
- Encouraging public transport use through the provision of information, incentives and linking infrastructure can make public transport an attractive alternative for the majority of trips.
- Car share schemes provide members with access to a vehicle without some of the major costs of owning one. This means people can access a well maintained car on the irregular occasions they need one, without having to pay registration, insurance and servicing costs.
- Centralised car garaging involves storing cars separately to dwellings, and ensuring other transport modes such as cycling, walking and public transport are convenient. Residents that require a car park can purchase a space in the car garage.
- Carpooling is the sharing of journeys so that more than one person travels in a vehicle.
- Plug-in hybrid electric vehicles (PHEV) allow the batteries to be charged using the electricity network. PHEV connected to ‘smart grids’ can be charged using off-peak electricity supplied from base load generators and renewable energy generators.
- 100% electric vehicles have zero tailpipe emissions. Electric vehicles powered using low or zero emissions electricity offer the potential to reduce greenhouse emissions from private transport.

Case study
The provision of high quality public transport services is a key element in reducing reliance on private vehicles, however it can also be a key to development quality and financial viability.

A major inner-city urban renewal project in Portland, USA, recognised that a new streetcar (tram) was a key ingredient for success, and so created a system whereby developers who would benefit from the establishment of the streetcar route would contribute to the upfront costs of its construction.

These contributions, as well as the proximity of specific sites to the route, were also linked to development densities, meaning developers close to the streetcar and who contributed more to the capital costs, were able to build to higher densities as a result. The establishment of the streetcar also gave developers the confidence to offer apartments and office space without a car space, reducing construction costs.

www.portlandstreetcar.org/

Image: Transport options, Copenhagen.
Reducing private vehicle use

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of new or improved public transport services</td>
<td>Significant greenhouse gas emission reductions through mode shift from private vehicles to public transport. Economic benefits of higher density development.</td>
<td><strong>Cost:</strong> Significant additional capital cost, and is likely to require engagement and financial support from government.</td>
<td>• New or improved public transport infrastructure may make more intense development possible and viable. • Property and land values are strongly influenced by proximity to good public transport services. If this increase in value can be effectively captured it can be used to offset capital costs.</td>
</tr>
<tr>
<td>Encouraging public transport use</td>
<td>Aside from walking and cycling, public transport modes are the most efficient and cost effective ways to get around.</td>
<td><strong>Context:</strong> Not generally seen as the role of a developer or owners corporation. <strong>Administration:</strong> May require ongoing administration to maintain impact.</td>
<td>• Can be managed by owners corporations, through provision of annual public transport tickets as part of fees, and ongoing support and information provision. • In multi-use development could be facilitated by retail store that also sells transport tickets. • Incorporate real-time timetable information into communal areas such as lifts and foyers.</td>
</tr>
<tr>
<td>Car share schemes</td>
<td>Every car share vehicle can remove the equivalent of between nine to thirteen private vehicles from the road.</td>
<td><strong>Physical constraints:</strong> Requires dedicated onsite car parking. <strong>Context:</strong> At present generally more viable in inner city locations with good access to public transport, where parking is limited and vehicle ownership levels are below average. Could facilitate provision of electric vehicles.</td>
<td>• May enable a developer to reduce private car parking provision and thereby release land or floor area for higher value uses, potentially increasing profitability. • Developers could provide parking spaces for companies that operate car sharing schemes in Melbourne such as Goget, Flexicar and Charter Drive (Green Share Car).</td>
</tr>
<tr>
<td>Centralised car garaging</td>
<td>The urban infill mixed use development in the suburb of Vauban in Freiburg, Germany, utilised this approach, contributing to a significant reduction in car ownership and usage. It also created a better urban environment that prioritised people over vehicles.</td>
<td><strong>Early adopter:</strong> Market demand for car-free development is yet to be proven. <strong>Design:</strong> Distance to centralised car garaging needs to be minimised to be viable option.</td>
<td>• The same garage could be used by multiple developments. • Contracts for rental of existing parking developments for exclusive or shared use by development would remove need for initial capital and ongoing costs. • Ongoing ownership and management can be undertaken by a specialist service provider, protecting the developer and other stakeholders from ongoing cost and risk.</td>
</tr>
<tr>
<td>Carpooling / vanpooling</td>
<td>Increasing car occupancy rates from 1.4 to 1.6 persons/car could reduce emissions by 2.8Mt/year by 2020 in Australia. Los Angeles operates comprehensive carpool and vanpool programs that result in a reduction of 730,000 commuter trips and over 10,000 tCO2/year.</td>
<td><strong>Flexibility:</strong> May not provide the desired level of flexibility or reliability. <strong>Ongoing administration:</strong> Requires ongoing administration. <strong>Community:</strong> Can foster greater sense of community within the development.</td>
<td>• Potential for onsite estates management company or owners corporation to administer. • Alternatively, could be administered by existing online carpooling schemes. • Often most successful when utilising existing networks such as workplaces and clubs, to overcome concerns with safety.</td>
</tr>
<tr>
<td>Preferential car parking for multi-occupant vehicles and electric vehicles</td>
<td>May encourage greater carpooling and/or greater uptake of electric vehicles. May allow for a reduction in car parking requirements.</td>
<td><strong>Cost:</strong> Low cost upfront. <strong>Administration:</strong> May be difficult to police in private parking areas. <strong>Design:</strong> Needs to be replicated at multiple locations to be effective.</td>
<td>• Collaboration possible with local councils, shopping centres and car park owners. • May address parking scarcity across multiple developments and localities. • Local councils could provide free or discounted parking permits to certain vehicles.</td>
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</table>
# Reducing private vehicle use

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<tr>
<th>Opportunity</th>
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<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
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</thead>
<tbody>
<tr>
<td>Incorporate electric vehicle charging infrastructure into car parking facilities</td>
<td>Electric vehicle uptake will rely heavily on the roll-out of supporting infrastructure including charging facilities. Early establishment of these facilities can protect against costly retrofits.</td>
<td><strong>Context:</strong> May be difficult to justify financially while the uptake of electric and plug in hybrid vehicles is in its early stages. <strong>Sustainability impact:</strong> Significant Greenhouse gas savings only achievable if electricity is low or zero emissions.</td>
<td>• Retrofitting at a later stage is likely to be a more costly option. • May reduce on site generation payback period, such as PV. • Offers an opportunity to demonstrate market leadership.</td>
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## Current practice

### Households without cars

<table>
<thead>
<tr>
<th>City</th>
<th>Data</th>
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<tbody>
<tr>
<td>City of Moreland (Victoria, Australia), 16% (2006 data)</td>
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<tr>
<td>Hammarby Sjöstad (Stockholm, Sweden), 33% (2005 data)</td>
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</tr>
<tr>
<td>Vauban (Freiburg, Germany, 2006), 46% (2000 data)</td>
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</tr>
<tr>
<td>The Commons (Brunswick, 2013), 100% (target)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Low</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>60%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
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<tbody>
<tr>
<td>Households without cars (%)</td>
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## Implementation time frame

- **Concept**
  - Identify opportunities for new and/or improved public transport services.
  - Identify potential for electric vehicle charging infrastructure.

- **Masterplanning**
  - Work with public transport stakeholders to define and progress opportunities.
  - Determine opportunities for innovative parking management to reduce car dependence.
  - Street layout to prioritise public transport, pedestrians and cyclists.

- **Design**
  - Detailed street design creating ‘shared spaces’ for different transport modes.
  - Incorporate ‘decoupled’ parking provision in residential and commercial building design.
  - Identify funding models.

- **Construct**
  - Establish key public transport and electric vehicle infrastructure early.
  - Create required management and governance structures.

- **Operate**
  - Management of car parking.
  - Education and promotion programs.
  - Collaboration with public transport provider to maximise patronage.
Active transportation

Introduction
Greater adoption of active forms of transportation, including bicycling and walking, is beneficial to both the environment and for the health of individuals. Active forms of transport can also reduce traffic congestion and demand on limited parking.

Giving pedestrians and cyclists the highest priority in the design process will encourage active forms of transportation within and around a site as it moves into operation.

Strategies to foster active transport
- **Sustainable travel planning** creates a blueprint for a development to achieve a sustainable, convenient and safe transport system and behaviours.
- **End-of-trip facilities** provide bicycle riders or walkers with secure storage, shower and changing facilities at their destination.
- **Safe and conducive environments** encourage walking and cycling.
- **Mode interconnection** refers to being easily able to change between rail, bus, tram and bike. It requires a focus on proximity, safe and clear connection between modes, facilities and timetable coordination.

Project context
The Commons, a Brunswick development comprising apartments, artist studios and two retail tenancies, has taken the bold step of becoming one of the first truly ‘car-free’ developments in Melbourne. The site’s location close to high quality public transport infrastructure, the mixed-use hub of Sydney road and other key services means that residents have low travel needs and a choice of public transport options.

In addition to this, the project will foster a healthy lifestyle supported by active transport choices. The site is located immediately next to the Upfield bicycle path, providing connections to the CBD and northern suburbs. Brunswick has an established bicycle culture which continues to grow, and it is expected that many residents will use bicycle for a variety of daily transport needs. To support this, the building will include ample convenient, secure and high quality bicycle storage on the ground floor. With a ratio of over three bicycle spaces per apartment, this measure represents best practice in Australia.

Image: Streets for people, Vauban Germany.
## Active transportation opportunities

<table>
<thead>
<tr>
<th>Opportunity</th>
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<th>Innovations and solutions</th>
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</thead>
</table>
| **Sustainable travel planning** | Sites participating in the Victorian TravelSmart program have achieved reductions in single passenger private vehicle trips of between 10% and 70%.                                                      | **Implementation:** Plans are often created as ‘static’ documents, with no mechanism for implementation or updating.  
**Owners corporation:** Owners corporations can have few resources or incentive to implement these plans.       | • Can be established and maintained by a broad site management service provider.  
• Local councils can include as planning requirements.  
• Can provide justification for increased development density or reduced car parking provision, delivering higher yield and increased return. |
| **Secure bicycle storage**      | Removes barriers to bike ownership and regular use, including fear of theft, convenience and space.                                                                                                             | **Physical constraints:** Adequate space can be difficult in higher density development.                                                   | • Space efficient and innovative bike storage systems are becoming readily available e.g. that allow two stories of bike parking in standard car parking heights.  
• Can be owned and operated by a third party provider, reducing upfront costs.                                      |
| **Bike hire scheme**            | Large annual emission reductions have been attributed to international examples:  
Paris: 32,330 tCO2 / year  
Copenhagen: 90,000 tCO2 / year  
Freiburg, Germany: 10,600 tCO2 / year                                                                 | **Physical constraints:** Space must be allocated for bicycle storage.  
**Cost:** A purely commercial operation may struggle to achieve financial viability (however the indirect social, economic and environmental benefits are significant). | • Funding or revenue generation through the sale of advertising on the bike storage.  
• Service could be provided by commercial operators such as the RACV that operates the City of Melbourne service. |
| **Mode inter-connections**      | Well integrated public transport modes can significantly reduce total trip times, acting as an incentive for greater public transport use.                                                                           | **Stakeholder management:** Different public transport modes are often managed by different organisations, making coordination challenging. | • The local government could act as a facilitator of this process.  
• Developer contributions to new public transport infrastructure within the development, such as stations, stops and signage, may increase the interest of public transport authorities in mode coordination. |
| **Provision of bicycle and walking paths** | In Sydney, introduction of bike lanes has increased the adjacent property values.  
85% of surveyed Sydney inner suburb residents said they would take up cycling if a safe bike network was provided.  
Dedicated bike paths in Cairns, Queensland have increased commuter bike use by 300%.  
Research found that bicycle parking in shopping areas in inner Melbourne generated over 3 times the economic expenditure than car parking generated. | **Local government:** Ownership and ongoing maintenance of paths often become responsibility of local government, requiring early engagement and commitment.  
**Social impact:** Eases traffic congestion, improves local air quality, reduces noise pollution and improves general health. | • Developer costs can be reduced by redirecting capital from car parking provision to cycling and walking infrastructure.  
Local government is increasingly willing to consider car parking dispensation where high quality active and public transport services and infrastructure are available. |
### Active Transportation

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
</table>
| **End-of-trip facilities** | Reduces a common barrier to commuting by bicycle by allowing commuters to shower and change conveniently. | **Physical constraints:** Requires space allocation.  
**Administration:** A large facility may require a dedicated manager. | • Requirements for facilities could be established in planning regulations.  
• Opportunity for specialist businesses to provide these facilities as a service.  
• Stand-alone facilities are available that are powered using PV panels, use solar hot water and treat greywater so that it can be discharged to surrounding gardens. |
| **Provision of safe and conducive environments** | 62% of Australians would consider riding a bike for many of their daily needs, but don’t due to safety fears. | **Social impact:** Community perception about the ‘rights’ of cars as the primary mode of transport can be difficult to shift.  
**Regulatory:** Needs to be supported by those agencies responsible for road design and maintenance. | • Urban design measures, such as coloured paving and clear signage, can clearly designate shared spaces and increase driver awareness of riders and pedestrians. |

### Current Practice

**Total trips using walking, cycling and public transport**

<table>
<thead>
<tr>
<th>City of Melbourne (Victoria, Australia)</th>
<th>City of Moreland (Victoria, Australia)</th>
<th>Hammarby Sjöstad (Stockholm, Sweden, 2015)</th>
<th>Vauban (Freiburg, Germany, 2006)</th>
</tr>
</thead>
</table>

### Implementation Time Frame

- **Concept**
  - Aims and targets for walking and cycling rates established early on and used to guide urban design concept.
- **Masterplanning**
  - Sustainable travel planning initiated early on. Plan for additional infrastructure provision and incorporate into costings.
- **Design**
  - Detailed urban design to ensure prioritisation of pedestrians and cyclists. Exact location and space requirements of secure bicycle storage.
- **Construct**
  - Cycling and walking infrastructure delivered early in a staged project, to develop active transport behaviours early.
- **Operate**
  - Ongoing maintenance of measures to ensure standards maintained and usage maximised. Establish lease and fitout conditions for commercial properties specify end of trip facilities.
The use of sustainable construction materials can dramatically reduce the ‘embodied’ environmental impact of a development; that is, the resources that are needed to manufacture and transport materials to their point of use.

Not all materials have the same impact on the environment, and steel, bricks and concrete can have higher embodied energy due to the greater levels of processing required in their production. However alternative products, including recycled aggregate concrete, can make a significant dent in this impact.

### Construction and material strategies

**Design for sustainability** in this context includes reducing consumption of resources by reducing house size, designing for durability and reusability, reducing reliance on scarce materials and incorporating materials with recycled content and low embodied energy. This approach is also discussed in the Zero Waste section of this document.

**Materials specification** includes defining principles for the selection of construction products. Sustainability principles include preferences for reused, recycled, low embodied-energy, and low toxicity materials as well as the use of materials from sustainable sources.

### Case study

One Brighton, a development in the city of Brighton, south of London, was delivered using the 10 principles of One Planet Living created by BioRegional and included a focus on sustainable materials specification. The project realised in some cases it would be necessary to work extensively with suppliers and sub-contractors to seamlessly incorporate new materials and techniques into the building, and to do so cost-effectively.

Through rigorous research and careful negotiation, the project was able to be delivered within a conventional construction budget while incorporating a range of highly innovative materials and construction techniques. Amongst other things, the site achieved 49% (by weight) recycled materials, used 100% certified sustainable timber products, minimised use of PVC and stipulated use of low-VOC materials.


Image: Passive design and diverse materials, Vauban Germany.
### Opportunities in construction and material selection

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design for sustainability</strong></td>
<td>Reduced transportation, material and waste disposal costs and Greenhouse gas emissions. 80% of environmental impacts are locked in at the design stage, so it is important that full consideration to material options is given at this point.</td>
<td>Cost and skill: Additional time and expertise may be required at the design stage.</td>
<td>• Additional design costs may be offset by reduced material costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Building longevity should be improved and maintenance costs reduced.</td>
<td>• Building Information Modelling (BIM) tools allow for the impact of different materials to be assessed at the design stage.</td>
</tr>
<tr>
<td><strong>Materials specification</strong></td>
<td>Reuse of materials from the demolition site can achieve both cost and emission savings. Use of sustainable versions or alternatives to steel, bricks and concrete can substantially reduce embodied energy.</td>
<td>Contractors: Construction contractors may attach a risk premium to working with unfamiliar materials.</td>
<td>• Training programs can be utilised to familiarise contractors with unfamiliar materials.</td>
</tr>
<tr>
<td></td>
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<td>Cost: Sustainable or low impact materials may be more expensive.</td>
<td>• Sustainable materials should become more cost competitive as demand increases.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Establishing a materials selection protocol can create certainty and allow comparison between various options.</td>
</tr>
</tbody>
</table>

### Implementation time frame

<table>
<thead>
<tr>
<th>Concept</th>
<th>Masterplanning</th>
<th>Design</th>
<th>Construct</th>
<th>Operate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider site context, determine potential</td>
<td>Consider modular construction. Consider design</td>
<td>Design for 100 year life. Embed design for</td>
<td>Educate consultants and contractors regarding project</td>
<td>Ensure future works and maintenance are guided by</td>
</tr>
<tr>
<td>materials for reuse or local sourcing.</td>
<td>for sustainability and deconstruction.</td>
<td>sustainability principles into design</td>
<td>sustainability targets and procurement objectives.</td>
<td>sustainable material selection policy.</td>
</tr>
<tr>
<td></td>
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<td>process</td>
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<td></td>
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<td>Educate consultants regarding project</td>
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<td>sustainability targets and procurement</td>
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<td>Quantity surveyors particularly</td>
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</table>
**Sustainable consumption**

**Introduction**

Building a sustainable development is just the beginning. Once the development is occupied, there are many everyday decisions that will affect the ongoing environmental outcomes achieved.

36% of Victoria’s ecological footprint is related to goods and services, and a further 28% is due to food consumption. Through minor changes to daily purchasing and consumption habits, consumers can significantly cut their ecological footprint, and in doing so support local traders and producers.

**Key sustainable consumption concepts**

- **Access to sustainable goods and services** by exercising control over the type of retail and/or commercial services available within or used by the development (by the developer itself or through the owners corporation) assists tenants and residents in making sustainable decisions and purchases.

- **Green contracts** require providers of services such as cleaning, gardening and maintenance to deliver their services in accordance with the environmental and social objectives of the development. For example, the cleaning contract may require the use of low toxicity or garden safe cleaning products.

- **Green leases** require retail or commercial tenants to deliver their products or services in accordance with the environmental and social objectives of the development. These requirements typically address the internal operations of the tenant, such as energy and water use, and the products or services provided by the tenant, such as a requirement for cafes to supply fair trade coffee or use recyclable take away containers.

- **Buying groups** can be established to facilitate the purchase of environmentally and socially responsible products and services such as low impact groceries, bicycle equipment and garden safe cleaning products. By establishing these groups (typically via the owners corporation), it can be easier for the occupiers to purchase products and services that are consistent with the environmental and social objectives of the development.

**Case study**

The 60L building in Melbourne was created as a showcase for the future of sustainable office development, and ensuring that the design and technology features were also coupled with sustainable operations was a key focus.

The use of ‘green leases’ has been a key way of ensuring this, with all tenants in the building required to enter into a green lease that requires their ongoing commitment and support of the building’s sustainability features. The lease also requires tenants to make sustainable decisions when undertaking fit-outs or renovations within their tenancy, specifying items such as efficient lighting, waterless urinals, openable windows and recycling facilities for staff.

These conditions foster a culture of shared responsibility for the building’s sustainability, which sees tenants collaborating to achieve the best outcome for the building as a whole.


**Image:** Garage sales are a great source of affordable, often good quality, secondhand goods.
### Sustainable consumption

#### Opportunities

**Opportunities for energy efficiency**

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access to sustainable goods and services</strong></td>
<td>Reduction in greenhouse gas emissions associated with household goods and services.</td>
<td>End user responsibility: Consumer choice is not something developers have a great deal of control over.</td>
<td>• A development may be able to capitalise on the increasing awareness and interest in sustainable and local produce through targeting innovative businesses and organisations as purchasers or tenants.</td>
</tr>
<tr>
<td><strong>Green contracts</strong></td>
<td>Ensures those services procured directly by the owners corporation are aligned with the overall sustainability goals of the development.</td>
<td>Education: Communicating to owners the value of procuring sustainable services is important, as other providers may offer similar ‘unsustainable’ services cheaper.</td>
<td>• Environmental offerings are increasingly available in the marketplace thus the cost is decreasing.</td>
</tr>
<tr>
<td><strong>Green leases</strong></td>
<td>Ensures ongoing environmental performance of development. The ACF 60L development use green leases for all tenants.</td>
<td>End user appeal: May deter some potential tenants due to being a relative new concept. Education: Small businesses in particular may require technical assistance to comply.</td>
<td>• Increasing sought by some tenants as part of corporate carbon neutral strategies.</td>
</tr>
<tr>
<td><strong>Buying groups</strong></td>
<td>Increased awareness and purchasing of goods and services that are more sustainable.</td>
<td>End user appeal: A buying group may not appeal to a mainstream audience. End user responsibility: Involvement in such groups is voluntary.</td>
<td>• Can be administered by owners corporation or private enterprises.</td>
</tr>
</tbody>
</table>

#### Implementation time frame

- **Concept**
  - Set targets for percentage of green contracts and green leases.
- **Masterplanning**
  - Consider the mix and type of commercial and retail tenancies to provide access to sustainable options.
- **Design**
  - Offer incentives to desirable businesses to take up retail leases.
- **Construct**
  - Commitment to maintaining the green leases needs to be embedded in the charter of responsible organisations.
28% of Victoria’s ecological footprint is due to food consumption, more than residential energy use and transport combined.

While awareness of the need to conserve water and reduce energy use is prevalent, the environmental impact associated with the production, processing, packaging, storage, transport and disposal of food are less well known. However, through minor changes to daily food purchase habits, consumers can significantly reduce this impact.

**Key concepts for water consumption**

- **Onsite food growing** can be encouraged through the provision of garden allotments or planter boxes on balconies.
- **Low impact food** produces fewer environmental impacts relative to other foods. The production process, packaging and transportation will generally vary from product to product, but generally, fresh foods and seasonal foods have a lower impact that processed and packaged foods, while animal products have a higher impact than non-animal based products.
- **Access to local fresh food amenities** requires ensuring that within the development or nearby there are sources of fresh food that can be accessed by residents or tenants without the need for private transportation.
- **Sustainable food waste management** involves recovering the valuable resources that are embodied in food waste, rather than disposing of food waste to landfill. Options for sustainable management of the organic waste stream are discussed in the zero waste section.

**Case study**

BioRegional’s development One Brighton, located in Brighton in the south of the United Kingdom, included, amongst its various sustainability initiatives, a focus on sustainable food.

In a higher density apartment development the provision of space for onsite food production can be difficult, however at One Brighton the developer used small raised garden beds on the communal ‘sky gardens’ as a means to support community-building, as well as providing an area for residents to grow vegetables. Individual apartments also have small herb planters, and the entrance area features space for residents to receive weekly deliveries of local, organic produce.

In Australian cities a range of local produce delivery services are emerging, such as CERES Fair Food, and small initiatives by developers, such as delivery spaces or promotion, can support residents making more sustainable food choices.


Image: Small allotments can provide for productive gardens at inner urban, higher density development.
Opportunities for sustainable food

<table>
<thead>
<tr>
<th>Opportunity</th>
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<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onsite food growing</strong></td>
<td>In many cases, food produced at the point of use is the most environmentally sustainable. Emissions from production, storage and transport are all reduced dramatically. Takes advantage of locally available water and nutrients. Reduces emissions related to food transport and storage. Creates opportunities for community interaction and social activities.</td>
<td>Physical constraints: Space availability is the key constraint in higher density development. Maintenance: Ongoing management and maintenance is required. End user appeal: Access to a community garden could expand the potential market for development.</td>
<td>• Public open space can be designed to include productive food growing areas. • Community gardens can be established and maintained by a local community group or private enterprise. • Local councils can allocate public open space funds from developers to set up and maintain community gardens.</td>
</tr>
<tr>
<td><strong>Encourage low impact food</strong></td>
<td>Need for, and impacts of, transport and storage are minimised. Packaging materials can be made from lower impact materials, such as cardboard. Packaging waste is minimised.</td>
<td>End user appeal: May not appeal to a mainstream audience if marketed incorrectly. End user responsibility: Participation in such programs is voluntary. Physical constraint: May require allocation of space for secure storage of food deliveries.</td>
<td>• Encouraging low impact food could be an element of an owners corporation’s lifestyle offering. • Community/shared space could be made available for secure storing of deliveries from fresh fruit and vegetable distribution organisations such as CERES and Aussie Farmers Direct.</td>
</tr>
<tr>
<td><strong>Access to local fresh food amenities</strong></td>
<td>Reduced greenhouse gas emissions related to private vehicle use for food transportation.</td>
<td>Ability to control: Broader access to certain types of retail can be beyond the developer’s control.</td>
<td>• Local governments can incorporate the requirement for provision of local food supply into the policies and plans as per the City of Wodonga and Baw Baw Shire.</td>
</tr>
<tr>
<td><strong>Sustainable food waste management</strong></td>
<td>It is estimated that Victorians throw away $2.5 billion worth of food every year, mostly fruit and vegetables. Resource recovery of the food component can reduce waste disposed to landfill by approximately 40%. For every kilogram of food waste sent to landfill, about 1kg of Greenhouse gas emissions is produced.</td>
<td>End user responsibility: Requires tenants/residents to separate organic waste and developments to provide storage facilities for this waste. Design: Offsite or onsite treatment of waste is possible and can be scaled to meet needs of specific development. Refer to the zero waste section for further details.</td>
<td>• Developments can work with food charities, such as, OzHarvest, Fareshare, Second Bite and Foodbank to organise regular collection of excess food. • Nillumbik Council collects food waste as part of their standard weekly garden waste collection service. • Onsite treatment systems that have generic approval by EPA Victoria exist thus only local planning approval is required.</td>
</tr>
</tbody>
</table>

Implementation time frame

- **Concept**
  - Consideration of onsite or nearby offsite food growing offering.
  - Consideration of existing and proposed local food supply.
  - Food waste management should be included.

- **Masterplanning**
  - Allocation of land or floor area for food production, transportation and storage to be determined.
  - Consideration of issues such as solar access for food growing areas.

- **Design**
  - Investigate alternative food growing structures such as vertical garden beds.
  - Link food growing to water reuse and recycling and to waste management.

- **Construct**

- **Operate**
  - Ongoing ownership and management of on site food growing areas.
Reducing water consumption

Introduction

The overall reduction of water use, and in particular potable water, is the primary opportunity in developing a sustainable approach to water.

Many measures, such as water efficient appliances and fittings, are becoming common in new developments. These, combined with minor behaviour changes, can make a significant difference to our use of this limited resource.

Key concepts for water consumption

Water efficient appliances and fittings use less water compared to similar products. Most appliances and fittings that use water are now labelled according to the Water Efficiency Labelling and Standards (WELS) scheme.

Water efficient landscaping and gardens can reduce watering and irrigation needs of individual households and the common areas. This can include selection of indigenous and drought tolerant plants, mulched garden beds rather than lawns and use of subsurface irrigation and soil conditioners to reduce watering needs.

Case study

Regulation and changes in industry practice have meant that new development in Victoria generally includes water-efficiency fixtures such as taps and shower-heads. Other appliances, such as washing machines and dish washers, can account for a significant proportion of household water consumption and represent another opportunity to reduce overall potable water use.

Developer VicUrban worked with Harvey Norman to offer buyers at The Nicholson a discount on appliances for their new apartment, with a focus on highly efficient models. By providing an incentive for residents to choose high efficiency appliances, VicUrban has been able to further influence the ongoing sustainability of the project in a manner not normally within the control of a developer.

http://www.vicurban.com/thenicholson

Image: Water efficient fixtures are now commonplace in new developments.
## Reducing water consumption

### Opportunities

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
</table>
| **Water efficient appliances and fittings** | Kogarah Town Square redevelopment in Sydney reduced reticulated water demand by 42% using conservation measures including AAA rated toilets and showerheads, flow restrictors and aerated taps in conjunction with rainwater capture and reuse. | **Cost:** There may be a small additional upfront cost.  
**Cost:** There can be a split incentive where the developer bears cost, owner reaps water and energy savings. | • If costs are passed on to purchaser, there is only a short payback period.  
• Reduces energy usage associated with water heating.  
• Can be achieved within a mainstream offering.  
• Some water efficiency measures are now part of minimum regulatory standards. |
| **Water efficient landscaping and gardens** | With around 19% of household water used in the garden, careful landscaping design and plant selection can make a significant difference to ongoing water use. | **End user responsibility:** For individual garden plots, difficult to ensure home owners retain water efficiency flora. | • For communal garden plots requirement of continued use of water efficient plants can be included in owners corporation rules. |
| **Minimise distance between water heating system and wet areas** | Showers account for the majority of water usage within households. Reducing the time taken for hot water to reach place of use can significantly reduce water consumption. | **Technical:** Must be balanced against other design considerations, including overall energy efficiency. | • An alternative solution is to install hot water recirculation systems that do not consume electricity, which prevent water from coming out of tap until water is warm.  
• A reduction in pipework can reduce construction costs. |

### Current practice

**Litres per person per day**

**Current practice:**

<table>
<thead>
<tr>
<th>Hammarby Sjöstad (Stockholm, Sweden, 2015, mixed use). 100L</th>
<th>Victoria (Australia, 2010, residential). 150L</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>60</td>
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<tr>
<td>80</td>
<td>100</td>
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<tr>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>160</td>
<td>180</td>
</tr>
<tr>
<td>200</td>
<td>230</td>
</tr>
</tbody>
</table>

**Litres per person per day (target)**

### Implementation time frame

**Concept**

Set potable water reduction targets.  
Set water consumption targets.

**Masterplanning**

Set efficiency standards for water fittings.  
Include use of water efficient landscaping.  
Consider layout of buildings to minimise hot water distribution distances.

**Design**

Ensure landscaping and gardens incorporate use of water efficient plants.  
Ensure owners corporation rules stipulate replacement plants must be water efficient.  
Ensure location of wet areas minimises distance to water heating systems.

**Construct**

**Operate**

Ongoing support and information to residents to ensure infrastructure is correctly used and sustainable water use behaviours are established.
Water reuse

Introduction

Onsite water collection and reuse can significantly reduce potable water consumption. Additionally, water reuse reduces demands on centralised water treatment facilities, reticulated potable supply and storm and sewage drains. It also reduces or avoids the need for infrastructure upgrades, saving significant costs over time.

Key concepts for water reuse

Rainwater usage requires the installation of tanks to collect water runoff from roofs. Rainwater can be connected to toilets, laundry, showers or garden watering systems, or can be accessed manually via a tap for other outdoor uses such as car washing. Treatment of rainwater for these uses is generally minimal.

Green roofs are partially or completely covered with vegetation. The vegetation slows and reduces stormwater runoff. They can also regulate internal building temperature by reducing heat retention and acting as insulation.

Greywater is wastewater from washing machines, showers, basins and taps (except the kitchen tap). Greywater can be reused outdoors as well as indoors for toilet flushing and clothes washing.

Blackwater, or sewage, is wastewater from toilet fixtures. Reuse of blackwater after onsite treatment is generally only permissible outdoors for subsurface irrigation. Onsite systems must be approved by EPA Victoria.

Recycled water reticulation is the use of recycled water from an offsite large scale water treatment facility. This requires two sets of pipes – one for drinking water and one for recycled water – to be connected to the development. The recycled water pipe is connected to toilet, garden and outdoor uses. Due to the requirement of an additional pipe this option is mainly suited to greenfield sites.

Case study

Ecovillage at Currumbin, a residential subdivision close to the Gold Coast, has established itself as a leader in many aspects of sustainable water management. The site’s overarching aims to become water self-sufficient and to be disconnected from both water supply and sewerage networks have been achieved. With around 70 houses now built and occupied, a combination of highly efficient fixtures, appliances and landscaping, rainwater collection and reuse and onsite blackwater treatment and reuse has meant that residents avoid paying any of the standard water authority supply and sewerage charges.

In a part of Australia facing increasing pressure around water consumption, the project is able to operate knowing it has full control over its water supplies and waste-water treatment.


Image: Watertank at 8.5 star development, WestWyck in West Brunswick.
<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rainwater collection and reuse (individual)</strong></td>
<td>Can replace potable water in many applications, including toilet flushing, clothes washing and irrigation, which constitute a major part of daily domestic water use.</td>
<td><strong>Cost:</strong> Upfront costs, although now that rainwater tanks are required by regulation in many developments, these costs are absorbed into the total construction cost.</td>
<td>• Water tanks have become a standard part of residential development, and in some cases are mandatory. • Can be used as an interesting design feature and can also act as a thermal mass.</td>
</tr>
<tr>
<td><strong>Rainwater collection and reuse (communal)</strong></td>
<td>The Kogarah Town Square redevelopment in Sydney captures 85% of all rainwater; 60% is reused to flush toilets the rest to irrigate gardens. The 60L building treats rainwater using three-stage filtration and UV sterilisation to bring water to drinkable standard.</td>
<td><strong>Technical:</strong> Potential requirement for metering if rainwater used by individual premises.</td>
<td>• Can be treated on site to supply drinking water requirements, reducing reliance on reticulated water supply.</td>
</tr>
<tr>
<td><strong>Greywater treatment and usage</strong></td>
<td>Reusing treated grey water for toilet flushing can save around 50L of potable water and about 90L for washing machines in an average household per day.</td>
<td><strong>Context:</strong> Since introduction of water restrictions, greywater has become commonly reused by individual dwellings (often without treatment) for garden watering hence has high community acceptance levels.</td>
<td>• Government incentives may exist to support upfront costs. • Developments can negotiate with water authorities for reduced sewage charges, which would offset additional capital costs that may be passed onto owners/tenants.</td>
</tr>
<tr>
<td><strong>Blackwater treatment and usage</strong></td>
<td>The 60L building uses treated blackwater for all toilet flushing and landscape irrigation. The blackwater is successively treated by sedimentation and digestion, bio-filtration, and then clarification. After which it undergoes a separate two-stage filtration and UV sterilisation process.</td>
<td><strong>Physical constraints:</strong> Space requirements. <strong>Ongoing maintenance:</strong> Management of nutrient levels and salinity in receiving environments.</td>
<td>• Avoids or reduces reticulated potable supply infrastructure upgrades, although the benefit of this is not apportioned to the developer. Developments can negotiate with water authorities for reduced sewage charges, which would offset additional capital costs that may be passed onto owners/tenants.</td>
</tr>
<tr>
<td><strong>Biological blackwater treatment</strong> e.g. worm farms and evapotranspiration beds</td>
<td>The Westwyck development treats blackwater on site. Solids are treated by worms while the liquid is fed into evapotranspiration beds. Due to limited space, a proportion of the blackwater is released into the sewage system untreated.</td>
<td><strong>Physical constraints:</strong> Space requirements. <strong>Ongoing maintenance:</strong> Management of nutrient levels and salinity in receiving environments. <strong>Costs:</strong> Upfront costs can be prohibitive.</td>
<td>• Avoids or reduces reticulated potable supply infrastructure upgrades, although the benefit of this is not apportioned to the developer. Developments can negotiate with water authorities for reduced sewage charges, which may offset additional capital costs that may be passed onto owners/tenants.</td>
</tr>
<tr>
<td><strong>Recycled water reticulation</strong></td>
<td>A ‘third pipe’ system provides for the optimal use of recycled water from onsite or near-site facilities, and can replace potable water for the majority of toilet flushing and irrigation needs, and may be suitable for laundry use.</td>
<td><strong>Suitability:</strong> Often not practical or affordable for refurbishment or small-scale development. <strong>Suitability:</strong> Suitable for high density applications where limited rain and storm water collection opportunities exist.</td>
<td>• Aurora capital costs of the recycled water were estimated to be $5,500 per lot. • Planning requirements can be utilised to require connection to third pipe system, ensuring demand for a large treatment system.</td>
</tr>
</tbody>
</table>
**Water reuse**

**Current practice**

Percentage of water for landscape irrigation that will be sourced from onsite rainwater collection or recycled site water

**Current practice:**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>1 Bligh St (Sydney, Australia, 2010, office)</th>
<th>1-25 Harbour St, Darling Quarter (Sydney, Australia, 2010, office)</th>
<th>39 Hunter St (Sydney, Australia, 2008, office)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-25 Harbour St</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>1 Bligh St</td>
<td>90%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>39 Hunter St</td>
<td>90%</td>
<td>90%</td>
<td></td>
</tr>
</tbody>
</table>

**Implementation time frame**

- **Concept**
  - Set potable water reduction targets.

- **Masterplanning**
  - Assessment of water reuse and recycling options should be completed.

- **Design**
  - Maintenance plans need to be established.

- **Construct**
  - Ensure contractors understand system installation requirements.

- **Operate**
  - Ongoing maintenance required.
  - Ongoing education of residents and contractors required to ensure health risks are minimised.
Introduction

Stormwater negatively impacts on receiving environments by transporting gross pollutants, suspended solids, nutrients and heavy metals to waterways. It can also cause localised flooding and other environmental damage.

A combination of various techniques can be utilised to achieve improved stormwater management.

Key concepts for stormwater management

**Infiltration trenches, swales and litter traps** collect and filter stormwater by diverting water through vegetated filtration systems. These systems are typically used on the side of the roads and footpaths and can be retrofitted to existing developments.

**Bio-retention systems, or rain gardens**, are landscape features that collect the rain and slow down its movement. These can be created using vegetated or paved areas, or a combination of both.

**Porous surfaces** allow for stormwater to seep into the ground gradually, reducing the volume of water flowing into drainage systems, resulting in less drainage blockages during heavy rainfall.

**Constructed wetlands**, streams and lakes can be used to capture excess stormwater. Infiltration swales and bio-retention systems are often connected to such areas either using existing topology or conventional piping.

**Rainwater tanks** assist in reducing stormwater runoff volumes during rainfall events, by providing temporary storage and delayed release, and can reduce incidence of localised flooding.

**Green roofs** are partially or completely covered with vegetation. The vegetation slows and reduces stormwater runoff. They also regulate internal building temperature by reducing heat retention and acting as insulation. This other benefit is discussed in the zero carbon section.

Case study

The Coburg stormwater harvesting project, to be delivered in Melbourne’s inner-north as part of the urban regeneration project ‘The Coburg Initiative’, is a partnership project between Yarra Valley Water, Moreland City Council and Melbourne Water. The project will harvest stormwater from two existing drains, transferring the water to a large underground tank before treating the water onsite and distributing it around the precinct for use for flushing toilets, washing clothes and irrigating open space.

The project will have a major impact on the water use of the current and future development of the precinct and is expected to save up to 213 million litres of drinking water each year and significantly reduce pollution of the nearby Merri Creek by reducing nutrients, litter and flow volumes associated with stormwater runoff.

## Opportunities for stormwater management

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Potential impact</th>
<th>Challenges and considerations</th>
<th>Innovations and solutions</th>
</tr>
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<tbody>
<tr>
<td><strong>Use of infiltration trenches, swales and litter traps.</strong></td>
<td>Use of these features in the Lynbrook Residential Estate in Victoria achieved a 50% reduction in stormwater quantity, slowed runoff significantly and improved quality by 75%.</td>
<td><strong>Suitability:</strong> Most applicable at the larger development scale. <strong>Fringe benefit:</strong> Vegetated option also provides landscaping. <strong>Context:</strong> Contractors are familiar with these systems as they typically form part of drainage systems in rural areas and along highways.</td>
<td>• Filtration systems can be placed below ground level allowing for traditional street and landscape appearance.</td>
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<tr>
<td><strong>Use of bio-retention systems, or rain gardens.</strong></td>
<td>Reduced flood risk.</td>
<td><strong>Fringe benefit:</strong> Vegetated option also provides landscaping.</td>
<td>• CSIRO has published tool kits that provide design solutions for various types of developments.</td>
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</table>
| **Maximise porous/permeable surfaces.**         | Reduced flood risk.                      | **Physical constraints:** Limited potential in high density developments. **Suitability:** Suitable at an allotment, streetscape and precinct level. | • Wide variety of manufacturers and products available hence can be tailored to suit specific site.  
• Planning requirements can specify ratios of permeable surfaces. |
| **Use of constructed wetlands, streams and lakes.** | Reduced flood risk. Improved microclimate: reduces heat island affect. | **Suitability:** Most suitable at precinct scale. **Physical constraints:** Requires significant land hence suitable only to larger sites. **Fringe benefit:** Provides landscaping and recreational amenities. | • CSIRO has published tool kits that provide design solutions for various types of developments. |
| **Rainwater tanks**                              | Reduced flood risk.                      | **Suitability:** Suitable at an allotment, streetscape and precinct level. **Benefit:** Delays and reduces quantity of rainwater entering stormwater system. | • Underground storage tanks can be used where available land is limited.  
• Can be treated onsite to supply drinking water requirements, removing the need for use of any reticulated water supply. |
| **Green roofs**                                  | Green roofs can reduce total stormwater run-off by up to 15% thereby reducing infrastructure upgrading costs associated with higher density. | **Cost and technical:** May need greater structural support, which may incur additional cost, unless incorporated from concept. **Maintenance:** Ongoing maintenance and management required. | • Portland City Council (Oregon) reduces stormwater charges if green roofs/walls are implemented.  
• Can be maintained by the owners corporations. |
| **Stormwater management during construction**    | Prevents and reduces construction waste entering the stormwater system. | **Education:** Training of contractors may be required. **Coordination:** Difficulty of managing number of individuals working on-site. **Technical:** Streetscape and prescient level infiltration and bio-retention systems in place prior to commencement of construction. | • Detailed guidelines provided by EPA Victoria. Infiltration and bio-retention systems can be protected by fencing off, using geo-textile fabric placed in entry pits to gravel trenches, and use of sediment fences and hay bales. |
## Stormwater management

### Implementation time frame

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<td>Set stormwater contaminants and flow reduction targets.</td>
<td>Site analysis of regional land-use zoning, climate and landscape characteristic.</td>
<td>Selection of stormwater treatment techniques that suit site. Maintenance plans should be established. Construction phase stormwater management plans should.</td>
<td>Ensure contractors understand stormwater techniques that are being used.</td>
<td>Regular maintenance of some stormwater treatment systems is required.</td>
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