ReNew

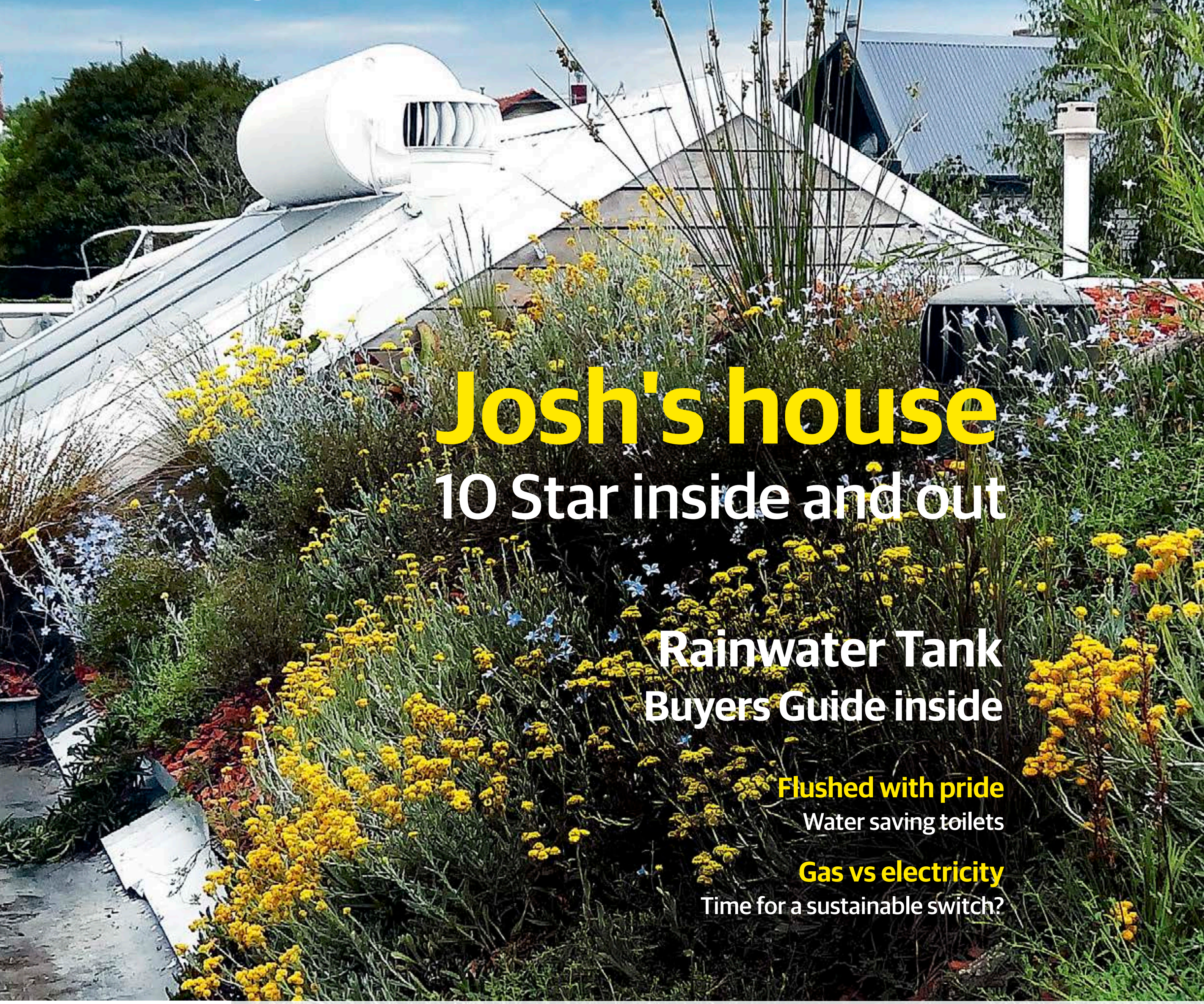
Issue 125

Technology for a sustainable future

Water saving issue

ON THE ROOF

Wildflowers, vegies and even chickens!



Josh's house

10 Star inside and out

Rainwater Tank
Buyers Guide inside

Flushed with pride
Water saving toilets

Gas vs electricity
Time for a sustainable switch?

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Darwin to Adelaide: our solar challenge guide; **The basics:** all about solar hot water; **DIY:** Netduino monitor project

WIN

a solar hot water system from Apricus!

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Special feature: water saving

← **Cover image: Brod Street.** Our cover shows Brod's green roof, which he built on the sloping west-facing roof of his 1890s Melbourne terrace home. The garden includes a colourful array of Australian native flowers, including the yellow common everlasting (*Chrysocephalum apiculatum*) and tall bluebells (*Wahlenbergia stricta*). He argues for the beneficial biodiversity potential of green roofs, along with their use in temperature moderation. Page 44.

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Methane matters
Is the future electric?

Richard Keech critically examines the sustainability of gas.

I'VE heard it said that 50% of what we've learnt is probably wrong; the trick is knowing which 50%. I submit that the received wisdom that gas is a clean fuel is probably wrong.

Consider more generally the burning of materials for their direct energy content. The use of wood, then coal, then oil and gas has underpinned the entire arc of human progress and achievement. But the advent of electricity meant much of that combustion no longer took place with the end user. At a time when renewable energy sources such as solar thermal, solar PV and wind can displace increasingly large amounts of that burning, why are we still persisting with policies that favour the burning of gas?

Perverse policies

At present in Australia fossil methane gas provides about 25% of all the energy to homes and business. It is generally viewed favourably as a safe, cheap and clean fuel.

That prevailing view of gas is influencing environmental policy. For example, various state rebates favour gas hot water units. This is based on the idea that gas produces fewer carbon emissions than the coal-fired electricity required for an equivalent electric hot water system.

But the electricity for a hot water system does not have to come from coal. Although it is still true that most of our mains electricity does come from coal, retail electricity customers have the option to source their power from renewable sources.

A policy that penalises hot water services because of the upstream deficiencies at the generator is perverse; in fact, the lowest emissions way of heating water is to use electric (or electric-boosted solar) hot water with zero-emission electricity.

Gas vs coal emissions

The direct emissions from burning gas are about half those of burning brown coal. The problem here is that 50% fewer direct emissions does not equal low emissions—and arguably hinders the push to the level of long-term emission reductions that we need. The direct emissions from burning gas are about 51 kg CO_2/GJ—still a high value in absolute terms.

Per unit of energy delivered, the emissions associated with gas are increasing as conventional gas reserves are depleted and unconventional forms of gas such as coal-seam gas and shale gas are brought into production. Emissions from ageing conventional reserves are also going up. In these reserves, it is necessary to actively compress where previously the gas came out under its own pressure. In addition, extra processing of the gas stream is required as progressively lower quality reserves are tapped, with entrapped CO_2 separated and vented to the atmosphere.

Fugitive emissions

Combustion emissions are not the only emissions associated with gas. The net emissions are also influenced by leakage, or 'fugitive' emissions. Two main factors influence the calculation of emissions from the leakage of gas: a) the global warming potential (GWP) of methane, and b) the rate of leakage of methane in gas production, processing, distribution and consumption.

Warming contribution of methane

The warming contribution (or GWP) of atmospheric agents other than CO_2 are significant, and dealing with them has been called the 'second front in the climate war'. It is estimated that methane has contributed about 30% of total human-caused warming since 1750.

As shown in Table 1, official estimates of the GWP of methane, stated relative to the effect of CO_2, have increased over time. Because different warming gases last different times in the atmosphere, it is customary for both 20-year and 100-year GWPs to be cited.

So which GWP figure to use? The current Australian government guidelines still use the older value of 21. Given the increasingly compressed timeframe for effective action in reducing emissions, the use of the 100-year GWP no longer seems appropriate. It is more reasonable to use a GWP timeframe consistent with the time remaining for mitigation efforts to be effective. The IPCC is soon to release an updated assessment. In the meantime, widely cited research by Shindell of NASA estimates the 20-year GWP as 105.

The other factor in Table 1 is the residence time: how long the gas lasts in the atmosphere. Methane has a stronger warming effect than CO_2, but a shorter residence time—about 12 years rather than centuries. Interestingly, because of this, the benefits of reduction in methane will be felt more quickly than reductions in CO_2.

Production leakage rates

The current Australian standard method for calculation of methane production leakage rates uses an assumed leakage rate of 0.12%.

The sunny side of the street
Solar cars evolve

Amy Rolfe checks out the cars competing in the 2013 World Solar Challenge, powered by nothing but solar energy.

THE battle for efficiency and sustainability can be seen in everything from recycling bins to our rooftops as Australian society becomes more concerned about the damage our way of life is having on the environment. One sector of our lives, however, has remained relatively untouched—our cars. The electric car movement has begun to work on this problem as they integrate with rooftop solar systems and upgrade petrol vehicles with electric motors and increasingly light lithium battery packs. But another group of enthusiasts has taken a different approach.

The World Solar Challenge (WSC) has been running since 1987—a marathon 3000 km journey from Darwin to Adelaide powered by nothing but solar energy. Teams leave Darwin and drive as far as possible until 5 pm each day, when they must stop wherever they are and set up camp until the next day. In 2013, 48 teams from 24 countries are participating in the WSC.

The vehicles fall into three different classes—the Michelin Cruiser class, the Go Pro Adventure class and the indubitably gorgeous Challenger class.

The Cruiser class is created for practicality—cars that would meet road registration requirements in their country of origin and carry the driver and at least one passenger.

The Adventure class consists only of cars that have already participated in previous races, including the WSC.

The Challenger class is at the forefront of design, striving to create faster, sleeker and more energy efficient cars than any that have ever graced the Stuart Highway. This year, 28 teams have cars in the Challenger class. Two of these teams are Australian: TeamArrow, a Queensland-based team, who are participating for their first year ever with the Arrow1, and the University of Western Sydney, with their vehicle the SolAce.

Two other Australian teams, the TAFE SA Solar Spirit team with Solar Spirit 3 and UNSW Sunswift with eVe, are partaking in the Cruiser class, and the Aurora Vehicle Association are participating in the Adventure class with their familiar car, the Aurora Evolution.

A guide to form

The Aurora team manager, Andris Sampsons, gave us an insider's opinion on the likely top contenders this year: "The Challenger class represents the pinnacle of solar vehicle efficiency. Based on previous form and their new vehicles it looks like the top picks would be Nuon Solar Team, Nuna 7 (Netherlands), Tokai University, Tokai Challenger (Japan) and University of Michigan, Generation (USA)."

But he notes: "In pushing the envelope on efficiency and performance, some teams are pushing the design rule boundaries and it will be interesting to see whether the prizewinner will be ultimately determined by post-race protest, rather than on the line placing."

We get an update from the Australian teams as they enter the final stages of preparation for October's 2013 World Solar Challenge.

UNSW Solar Racing Team

Vehicle: eVe
Class: Cruiser

The UNSW Solar Racing Team, Sunswift, is working tirelessly on their solar car beauty, eVe. With eVe nearing completion, the Sunswift team holds high hopes for their solar sports car to be a true contender in this year's new Cruiser class. It is nothing short of hectic in the Sunswift workshop as the WSC 2013 approaches, but the team is excited, focused and doing all they can to ensure that eVe's revolutionary design hits the road.

Sunswift is not only looking to enter WSC 2013 with all guns blazing, but also to illustrate the amazing possibilities of solar energy in the car industry. Their solar-powered innovation hopes to strike an uncompromising balance between efficiency and practicality. The great progress that Sunswift is making would not be possible without the endless encouragement and aid of their sponsors and supporters. The team won't be resting until the elegant and environmentally friendly eVe is unleashed!

Josh's house and garden
Productive plans

Behind 10 Star Josh's House is a productive, water smart and shade-giving garden—and you can find the plans online, writes Jacinta Cleary.

AS a keen gardener in a dry spot like Perth, water has always been important to ABC's *Gardening Australia* presenter Josh Byrne. "From my late teens on we've always had water saving measures in place, and as a food gardener I'm always trying to come up with better watering systems." There was no doubt then that 'Josh's House' would be a water smart home.

Josh's House is the name of his ambitious building project in the Fremantle suburb of Hilton. Josh, an environmental scientist, runs a landscape and environmental design business while juggling a media career and a young family. As if not busy enough, he embarked on a "long-held dream" to build his own environmentally sustainable home and documented every step via the open-source Josh's House website, full of house and landscaping plans, fact sheets and videos to inspire anyone to build an energy and water saving home.

The two dwellings have been built in just six and a half months, with construction finishing in May. The project comprises two 10 Star homes on an 1160 m² block, with one for his family and another for his sister-in-law. As tends to be Josh's way, there have been no delays creating a common productive garden around the homes, with an impressive water harvesting and recycling set up.

Image: Joel Barbitta

↑ Josh's home has a 10 Star sustainability rating and features passive heating and cooling and advanced water recycling systems.

Water cycle

"All in all we will use less than a third of the typical Perth water scheme consumption while maintaining a beautiful and productive shady garden," says Josh. To do this, he's designed an integrated water system around what he calls his "water priorities", with rainwater capture and use at the top of his list, followed by greywater and bore water. One water source feeds into another helping to keep as much water as possible for reuse or infiltration within the property.

Rainwater tanks and beyond

With rainwater collection a priority, an efficient rainwater system has been installed. Each home has a wet system rainwater tank, where the collection pipes run underground to connect multiple downpipes from different gutters. This makes the most of the 200 m² roof space available on each home. An underground diversion valve is fitted so that water that sits in the pipes for too long, possibly becoming stagnant, can be flushed into an underground soakwell to seep into the surrounding soil.

Josh estimates mains water backup will be needed just a few months of the year. His house has a 20,000 litre poly rainwater tank and the other has a 12,000 litre tank, both plumbed to all areas inside and some parts of the garden. The first rain of the season that might contain roof debris and dirt is also flushed into the soakwell, and drinking, cooking and bathing water is filtered through sediment and carbon filters.

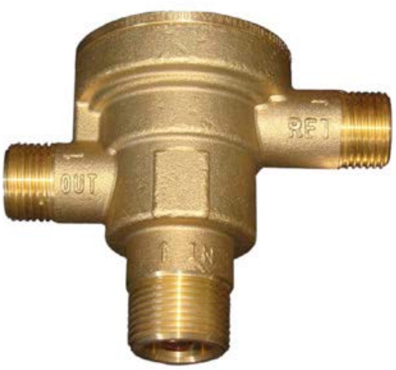
Practices and plumbing
Water saving ways

Water saving doesn't have to be expensive or difficult. Jacinta Cleary reviews the best practices and latest technologies to help save water around the home.

MOST water-conscious householders have befriended a bucket or two in the last decade to save water around the home, with Australian Bureau of Statistics figures showing household water use dropped 8% in 2011. With water bill increases and more dry spells on the way, water is still as precious as ever, so how can you save even more water around the home?

Diverters

Hot water taps that are slow to warm can mean cold water goes down the drain. Hot water recirculation systems help by diverting the cold water in the hot water line back to the hot water tank or another use, such as into a rainwater tank, until the water hits the right temperature. The easy-to-install Redwater Diverter is a simple brass valve that diverts cold water, while another retrofit option is the Act D'Mand Kontrol System, a pumped system that recirculates the water (and is available from the ATA shop). Or simply collect the cold water in buckets to save thousands of litres of water each year.



↑ The Redwater valve simply diverts otherwise wasted cold water from the hot tap to another use.

↑ The Every Drop Shower Saver lets you shut off the water while soaping up, reducing shower water use.

Bathroom

Around 20% of household water use is in the bathroom, according to SA Water, so improvements to showers, toilets and taps can help save water. The Every Drop Shower Saver is a paddle-like device retrofitted to the shower that quickly switches the water flow on and off while soaping or shaving. With a flick of the paddle the water comes back on at the same temperature and flow, stopping water going down the drain unnecessarily and saving energy from water heating.

Save more water in the bathroom by putting flow restrictors and aerators on the taps and install a low-flow showerhead. Place a brick or water bottle in the toilet cistern to reduce how much water it holds. Or install a dual-flush toilet with a hand basin where you can wash your hands while the same water fills the cistern; for more details see the water saving toilet feature in this issue.

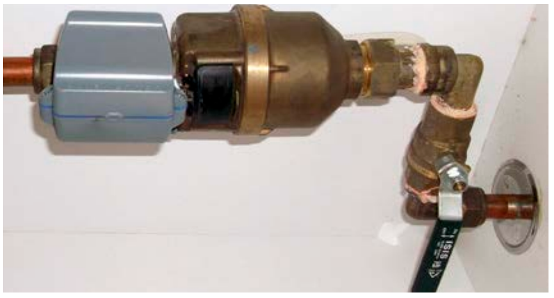
Greywater

A household can produce up to 400 litres of greywater a day and there are a number of simple ways to get this water to the garden. The Hughie Sink is a plastic bucket moulded to fit the shape of most kitchen sinks. Wash the vegies in it, pick it up by the handles and tip it on the fruit trees. The Solar Bathtub Greywater Pump takes bath or laundry water outside in around 10 minutes, and best of all it's powered by the sun. Or send greywater to the garden by attaching a wastewater diversion valve to the laundry or bathroom drainage pipes. Find out about more advanced greywater systems in the Greywater buyers guide in *ReNew 102*.

↑ The Hughie Sink lets you capture water used for many tasks for later use on the garden.

Smart water monitoring
Add a monitor to your water meter

Andrew Stewart from Aquamonitor explains how smart water monitors can hook into our mechanical water meters to help reduce water consumption—and make a building manager's life easier.



↑ The Aquamonitor wireless sensor unit simply mounts onto a pipe and the sensor unit is fitted to the meter. Different meter models require different sensor fitment, but most standard meters can take a sensor that allows them to become part of a wireless water monitoring system. Two meter models are shown at right with the reed switch fitted.

USING mains water has financial, community and environmental costs. Hidden from everyday life the water we use is collected, treated, pumped and distributed. After the water is used it is often processed in some way or flows as wastewater into our waterways and oceans. No matter where water is used there is usually an energy cost associated with water heating, washing machines, pumping and water treatment.

As electricity consumers we have become more aware of the need to reduce usage, use more energy-efficient appliances and to limit wasteful usage such as standby power. Along similar lines, as responsible consumers we diligently consider water efficiency when choosing fittings and appliances.

But what about water monitoring? Wireless water monitors have also become available that display real-time usage and so enable us to track the main users of water and uncover wastage through leaks. Even better, they can even be used with existing mechanical water meters.

The humble water meter gets smarter

Most homes and buildings are connected to a mains water supply through a mechanical water meter that is routinely read by a local authority for billing purposes and for water supply management.

In Australia there are many different models of installed meters, the most common supplied by Elster, RMC and Itron. Mechanical water meters have a register with dials that display total water usage. Typically the meter comprises two physically separate sections that are linked using a magnetic coupling. A wet section connects the water inlet and outlet and contains moving parts that move in proportion to the water flow. A separate second section contains the register which turns in unison with parts in the wet section, via the magnetic coupling.

The majority of mechanical water meters also have provision for fitting a reed switch to a recess in the body or face of the meter. As water flows through the meter the magnets within the meter turn and cause the contacts of the reed switch to open and close. Electronic equipment can sense and total the reed switch closures to determine the volumetric flow of water. Each contact closure represents a fixed measure of water volume that has passed through the meter. There are some meters that are designed for an optical sensor rather than a reed switch to indicate water flow.

Smart water monitors typically have a wireless module that connects to the meter using a reed switch or optical sensor, depending on the meter type. Fitting the reed switch or optical sensor is usually a simple DIY task not requiring any changes to the plumbing nor requiring the water to be turned off. With the wireless module fitted, the meter is transformed and data can be regularly sent to a wireless monitor or to a data collection device for display and analysis.

Better submetering

Water monitoring can also make a big difference in commercial buildings. A common practice in commercial buildings is to install water meters at key points within the building or site. These meters are termed 'submeters' as distinct from the main meter which measures the total volume used by the building. Facilities such as hotels may

Saving water in the suburbs
A water self-sufficient home

Richard Stanford describes his son's rainwater collection and greywater treatment system in suburban Sydney which makes the house 96% water self-sufficient.

MY son Ralph and his family undertook a major renovation of their small, semi-detached federation house in Randwick, Sydney, three years ago. Their aim was to create more space and transform the building into an energy-efficient one.

They endured more than a year of very slow progress but were finally able to return to a home transformed with a modern interior and much enlarged first floor, which still retains the original yard and heritage front. The frontage disguises the fact that the roof and walls now contain modern insulation, the windows are all double glazed and there is a 4.8 kW array of photovoltaic panels and a solar hot water system on the roof. Most interestingly though, the house is now 96% self-reliant for water.

The original plan to have a rainwater storage tank under the house was deemed impractical because of the unknown state of the foundations, built on sand. Excavating close to them could have been disastrous, so the second option of excavating for a smaller tank under the garage floor, at the rear of the property, had to be adopted. There is no room for surface tanks.

Knowing the roof area and the local rainfall average, my son estimated that a 10,000 litre tank, combined with recycling of greywater, might provide approximately 80% of water requirements. In the event, the builders managed to make the tank very close to 15,000 litres. It is a concrete structure with a heavy-duty flexible liner. It is trafficable, with a cast-iron manhole cover. A sealed rim outside the main cover with an aluminium cover over it prevents any spilt liquids seeping in through the manhole.

→ The reed bed treats greywater before final sterilisation. It measures just 2250 mm long x 820 mm deep and 1660 mm high, and contains around 900 mm of soil on 600 mm of gravel.

Between the roof and the tank, simple enough in themselves, there is an amazing and mystifying collection of tanks, pumps, filters and pipework. The gutters and downpipes are designed to be self-cleaning. The 200 mm half-round gutters, their outer edges lower than the inner edges, are arranged with the maximum fall possible within the confines of the fascias; the outlets are fixed under the gutters and all rivets in the outlets and gutter corners are installed inside out. These measures ensure a fast flow of water, with no ponding and no obstructions for the movement of leaves out of the gutters.

Cleaning the gutters, or any leaf guards, would not be practical because of their height and the restricted access between buildings. The outlets are 150 mm, reducing to 100 mm downpipes. The down pipe returns from gutter outlets to walls are at 45 degrees. The leaf diverters have covers to keep out the sunlight,which would otherwise encourage algae to grow; they are accessible from ground level and are easy to clean. First-flush diverters are fitted to all downpipes.

The downpipes feed an underground pipe that leads to the rainwater storage tank. There is an electronic monitor that indicates

Flushed with pride
Water saving toilets

Beth Askham takes us on a tour of some water saving loos.

TOILETS can flush away litre upon litre of potable water, with up to 25% of our home's water going down the toilet.* It used to be worse; before 1982 when dual-flush toilets were introduced, toilets in Australia had an average flush volume of 11 litres. Now, the most efficient toilets use around 3.3L per flush and to use less water than this we might need to radically change toilet design. New water-saving toilet designs in the pipeline incorporate air assistance, vacuum piping or urine separation.

How low can we flow?

Dual flushing is the standard for water-efficient toilets in Australia. The most efficient dual-flush toilets use 4.5L for a full flush and 3L for a half flush, with an average flush volume of 3.3L. These toilets are rated as 4 stars under the WELS rating scheme (the more stars, the more efficient the model). Some models with an integrated hand basin that flush with greywater reach 5 stars, but there are no 6 star toilets available at this stage.

Indeed, we may be at the limit of the minimum amount of water used for flushing. Too little water in a flush can create drainage problems as it's the water that pushes the waste along sewer drainage lines. Ways to get around drainage issues and still reduce the amount of potable water used includes flushing with greywater, using a Drainwave that releases water from your house in stored batches (see www.drainwave.com.au) or using another type of toilet that doesn't depend on water-such as those that use air pressure to flush or composting toilets.

Image: Caroma

↑ Caroma integrated hand basin and pan. Caroma and Roca (W + W) make integrated hand basin toilets that use basin greywater to flush. Royal Flush produces a cistern and hand basin retrofit.

Urine separation toilets

Urine separation toilets reduce the amount of flushing required. They are more common in Europe but there are some examples of their use in Australia. The University of Technology Sydney (UTS) Institute for Sustainable Futures is working to divert urine from their sewerage system by installing dual plumbing at its Barangaroo development and in their new UTS Broadway building in Sydney. They plan to reuse the urine's nutrients as agricultural fertiliser. "It could easily be argued that 'taking a leak' is our most apt description for going to the toilet as it literally involves leaking valuable resources into the waste stream," says Professor Cynthia Mitchell, who is leading the project.

Vacuum toilets

Vacuum toilets are increasingly being used in offices, public buildings and portable toilets, but it's still early days for them in residential dwellings. Vacuum toilets use less than one litre each flush and it's only to wash the pan. They essentially use atmospheric pressure to push waste into toilet piping that's kept at a lower pressure.

Pumps keep the piping network at a 55% vacuum and when a toilet is flushed, this drops to 35% before it builds back up. All waste is macerated and then sent to the sewer, avoiding any drainage issues. An advantage of vacuum toilets is that you can place them anywhere in the building layout without needing to account for gravity-fed piping, as the vacuum piping can remove waste vertically if needed. Managing Director John Neskudla of Vacuum Toilets Australia

Image: Vacuum Toilets Australia

↑ Behind a vacuum toilet.

Rooftop diversity
Beneficial uses of rooftops

From farming to education to biodiversity, Brod Street considers the many and varied uses of rooftops.

↑ Brod's native rooftop garden, built on the west-facing roof of his 1890s terrace home, provides a year-round display of botanic beauty as well as cooling for his home.

IN THE past, building practices embraced the use of rooftops for all sorts of beneficial uses—for food production, aesthetics, education and recreation.

The capital of rooftop variety must be New York where flat roofs once supported libraries, school sports, a school for the visually impaired, playgrounds and roof gardens. Today New York embraces green roofs as a cost-effective way to deal with a host of urban problems. For example, they help manage peak stormwater flows into the city's only sewer, which has to cope with both stormwater and wastewater. Reducing the volume of stormwater helps avoid the discharge of sewage into rivers and oceans (resulting in beach closures) when the sewer can't cope.

London has had a variety of roof uses, too. In 1921, a Mr Thomson used the Institute of Engineers roof, near Big Ben, for a farm of 200 rabbits and 36 chickens (60 eggs per week!), with the birds allowed to roam about the roof garden during less windy days.

In 1941, *The Argus* reported that Collins House in Melbourne possessed a large lawn on its roof, used for sitting on and eating lunch, or playing golf: "Collins House can provide rather a big surprise. On the roof is a well-kept lawn which is just a shade smaller than a tennis court. It has been there since the building originated with a group of enthusiastic golfers decided that their lunch hour could be well spent in the city if they could find somewhere to practise putting."

Green roofs today

Nowadays in urban Australia, most green roofs contain a low diversity of plants, usually introduced succulents and sedums. They are typically installed on a flat roof with between 100 and 150 mm of planting substrate over a drainage layer and a waterproof membrane, with the planting substrate consisting of 80% mineral and 20% organic mix.

It is not advisable to use general garden soil for green roofs as it is too heavy and too rich in nutrients. Most mineral mixes are a blend to achieve the desired outcomes. Scoria mixes often contain some crushed tiles, brick rubble and coarse sand in addition to the lightweight volcanic rock. Other mineral mixes might use waste ash from power stations for its water-

Communal water harvest
Healthy estate

Sharing water management among the houses on this estate makes sense in many ways, not least for the health of nearby Duck River, writes Mark Liebman.

Photo: Mark Liebman

↑ The parkland serves as both a public recreation space and a huge water tank for the residents.

ASHGROVE Estate is a housing estate in Sydney's west designed using the principles of 'new urbanism'. New urbanism principles include having smaller house lots with larger communal areas, designing for passive surveillance (for example having houses front parkland), and integrating water-sensitive urban design.

The estate was developed by Mirvac in 2006 and was awarded a NSW government's Green Globe Award in 2008 for its innovative water-management system, which is now saving 10 million litres of water a year.

Ashgrove was probably the first estate in NSW to harvest stormwater from the local road network. The treated stormwater is used to irrigate the estate's parkland and is also reticulated via a 'third pipe' to each house on the estate for toilet flushing, car washing and watering gardens. In effect, the stormwater system acts as a huge water tank for the estate, removing the need for rainwater tanks for each house.

Stormwater is more abundant and easier to collect at the estate scale than rainwater, but there are risks with using stormwater, compared to rainwater. Unlike rainwater from roofs, stormwater is carried in drains and comes into contact with the ground so, before using it, effective filtration and disinfection are required to remove sediment and pathogens. Suitable uses of stormwater include non-potable uses such as car washing, garden watering and toilet flushing.

Reviving Duck River

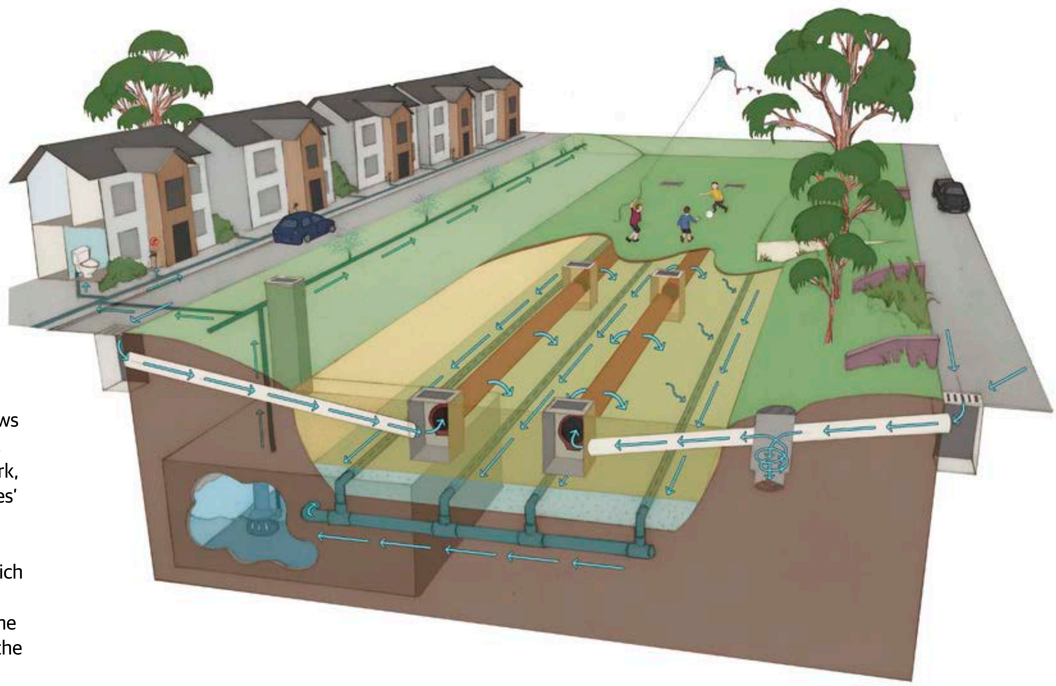
After filtration, excess stormwater runoff from the estate is discharged to the Auburn golf course, from where it makes its way into Duck River. Duck River's ecological health declined severely with development of its catchment post-WWII, but it is slowly being revived. This estate is certainly making a contribution.

Approximately 70% of the Duck River catchment is covered by impervious surfaces (which shed water almost every time it rains) and most of this is directly connected by gutter and/or pipe to Duck River. The estate has reduced stormwater flows by 10 ML/year which actually helps to protect the river from excessive levels of urban runoff.

The export of suspended solids has reduced by 80% and heavy metals are down to levels that protect the most sensitive macroinvertebrates (small creek insects). The system also retains 45% of nutrients which would otherwise cause algal blooms. Through stormwater harvesting not only are we reducing potable water demand we are also reducing excessive volumes and frequencies of stormwater runoff.

Treating the stormwater

The estate occupies 12 hectares, nine of which contain a mix of townhouses and



→ Figure 1. Illustration of the hybrid bioretention system used at Ashgrove Estate, showing the flows into the system from stormwater, and out of the system into the park, storage tank and the estate houses' 'third pipe' for toilet, car washing and garden use. The large brown pipes are the HydroCon pipes which filter water through the pipe wall. The cutaway at front left shows the 800 kL buried storage tank with the submersible pump visible.

Illustration by Sarah Laborde, Designer & Illustrator

houses. Nearly three hectares (25%) is public parkland which has multiple uses, one of which is to contain the stormwater and water infrastructure that serves the estate.

The estate uses a unique hybrid bioretention system to treat the stormwater to ensure that it is fit for its intended use.

As shown in Figure 1, the treatment train starts with gross pollutant traps which use centrifugal separation to remove large pollutants such as plastic bottles, litter and coarse sediment. The water is then directed into a series of hybrid bioretention basins. We call them 'hybrid' because they use a combination of treatment systems.

The runoff from typical smaller rainfall events passes through the walls of permeable concrete pipes. Normally pipes transport water from point A to B, but, instead, these pipes are designed to exfiltrate water through the permeable wall of the pipe and outward into a surrounding filter media. Produced in Australia by HydroCon (www.hydrocon.com.au), the pipes remove phosphorus, heavy metals and sediment from the stormwater as it permeates through the pipe wall. Several processes happen in the pipes including settling of sediment, adsorption and ion exchange.

After the water leaves the pipes, it passes into a filter system where biological processes facilitate the removal of nitrogen and additional phosphorus and sediment.

Larger flows from intense rainfall are not treated by the HydroCon pipes; instead, these flows are directed up to the ground where they pond on the surface and then seep down through the filtration media.

After passing through the filtration media the water is soaked up by a traditional agricultural drainage pipe, which allows water to come into the pipe through the slotted pipe. The filtered water is then stored in a 800 kL buried concrete tank and is UV-disinfected prior to use to ensure compliance with recycled water regulations.

Walking on water

There is a growing awareness of such bioretention systems, which are normally covered with reeds, sedges and water-tolerant plants. This system, however, uses grass instead of reeds and sedges.

This makes the space above the filter completely accessible to the public. Were it not for the flood hazard warning signs, most people who use the open space would never know they are walking on a stormwater filtration system.

The grass provides a solid vegetative mat with a good rooting depth and density, which

"In the future new estates might also include communal food growing areas, and use the abundance of stormwater to irrigate their crops."

is vital to maintain the porosity of the system and prevent it from clogging.

Using this approach, we were able to subtly weave water-sensitive urbanism into the fabric of the estate. Its use means that we did not need to segregate any land with reeds and sedges and we could maximise the opportunity for accessible public open space.

The bioretention basin also performs a flood-control function, helping to store floodwater during extreme storm events and thus solving an ongoing localised flood problem. In this sense it functions just like any other detention basin—an area of land set aside to allow the temporary storage of floodwater and so prevent uncontrolled flooding downstream.

The three-hectare investment in open space has thus had maximum impact. It serves to limit flooding and treat stormwater from the site and the surrounding catchment,

The aquaponics cycle
Organic matters

Geoff Wilson, director and editor of Aquaponics Network Australia, explains the recycling inherent in aquaponics systems.

AQUAPONICS is the 33-year-old name for symbiotic cultivation of plants and aquatic animals in a recirculating environment. It mimics natural systems originating in ages-old food-production practices in Asia, central and south America and the Middle East.

Organic aquaponics is now being pioneered in Australia in integrated systems to produce fresh organic food, including fish, crustaceans, molluscs, many vegetables, most herbs and some fruits. The systems have very low water use—usually about one twentieth of standard agriculture's water use (and sometimes much lower)—and can make use of solar energy for water and air pumping, and LED lighting.

In the best organic aquaponics systems the main regular input is just organic fish feeds, plus management time. Organic fish feeds can be produced in a home garden, via worm farming, insect larvae culture and algae production, for example.

Then, as a by-product of keeping fish in a closed system or tank, fish waste accumulates and the effluent-rich water becomes high in plant nutrients. This is toxic to the fish, but microbes convert key wastes to plant food. Plants then take up the nutrients and reduce or eliminate the water's toxicity for fish. Cleaned water is returned to the aquatic environment and the cycle continues.

Aquaponic systems do not discharge or exchange water. Water is only added to replace water loss from absorption by the plants or evaporation into the air.

Systems vary in size from small indoor to large commercial units. They use fresh or salt water depending on the type of aquatic animal and vegetation, though most are fresh water.

Photo: Charlie Vinz, Chicago. www.flickr.com/photos/vinzcha/

↑ A basic portable aquaponics system growing watercress, which shows the technology's simplicity. Other home-based designs cost more but can also grow more.

Aquaponics systems could provide 'protected cropping' next to home kitchens or restaurants. Brisbane-based Qponics is proposing aquaponics use for production of omega-3 oils, along with algal fish feeds. (Disclosure: I am a shareholder of Qponics.)

Sydney-based Urban Ecological Services is leading the way on large-scale production of fresh fish, vegetables, fruit and herbs. Another Australian company, Perth-based Algae-Tec, is pioneering lower-cost harvesting of algae for producing both energy and food. Its ideas have great relevance to more efficient aquaponics on a large scale.

A new Australian innovation is reducing water use even further, via solar-powered air moisture harvesting which condenses air moisture at a much lower cost than supply of municipal water.

Producing fish feeds from the recycling of organic matter has the added benefit that these wastes do not go to waste dumps and create methane gas. Aquaponics is also expected to produce little nitrous oxide—the greenhouse gas from agriculture which has 300 times the greenhouse effect of carbon dioxide. ✱

Geoff Wilson is a retired agribusiness journalist who runs Aquaponics Network Australia as a hobby, after 33 years writing about aquaponics from its 1980s start in the USA.

Saving water for a (non) rainy day
A rainwater tank buyers guide

A rainwater tank is one of the best ways to become more water self-sufficient, but which tank is right for your home? Lance Turner looks at the options.

Photo: PJT Green Plumbing

Slimline tanks can squeeze into otherwise unusable spaces.

RAINWATER tanks come in almost any size, shape and colour you can imagine, with a variety of materials to suit different preferences or usage requirements. So what should you look for when buying a tank?

The first decision you have to make is where the tank will be located. Where you place the tank will determine its size and shape, and possibly even its colour if it needs to blend into the surrounding vegetation or dwelling walls. A large yard offers a number of options. You could place it next to the house or shed, or even under the house.

You also need to consider how the water will get from the roof into the tank, as well as overflow piping. However, there are a number of different systems for plumbing a tank to a home's gutters that allow a tank to be situated some distance from the home, so this should probably not be an overriding consideration.

Tank materials

The six most common rainwater tank materials are concrete, fibreglass, plastic (usually polyethylene, often just called 'poly', or PVC, used in flexible bladder tanks), Aquaplate Colorbond (thin sheet steel with a colour coating on the outside and a waterproof coating on the inside), galvanised steel and stainless steel. Each of these materials has advantages and disadvantages, so let's look at a few of those.

Durability

A water tank can be a considerable expense, even after a rebate, so you want it to last as long as possible. The expected lifetime of any tank should be at least 20 years, and indeed, many tanks come with a 20 or even 25 year warranty. However, a number of factors will determine just how long the tank actually lasts, and that includes water quality, maintenance and positioning of the tank.

For example, plastic tanks are relatively immune to damage from salty water, so if your tank is regularly topped up from a bore or dam, then a plastic tank might be the best solution. However, if your tank only needs to hold rainwater, then any tank material should be suitable.

The tank's location can affect the lifetime of the materials. Ideally, the tank should be located in shade if possible, not just to keep the water temperature low and reduce evaporation, but also because some materials are degraded more rapidly by direct sunlight.

Most poly tanks will slowly degrade over time with exposure to the sun, despite having UV inhibitors added to the plastic. Because the plastic is being used to hold water, there are limits to how much UV inhibitor and other

Delivering less pollution
A Citroen Berlingo electric conversion

Rhys Freeman describes the successful conversion of a delivery van by the EV group at CERES in Melbourne.

FOLLOWING on from a direct current (DC) conversion of a Citroen Berlingo van over 2007–2009, CERES in Melbourne decided to convert a second van to electric drive, this time an AC conversion.

Alternating current (AC) motor conversions are not as common as DC conversions, due to higher costs and poorer knowledge of the technology among the conversion community. This is despite the fact that current commercial vehicles use AC brushless drive trains, either induction or permanent magnet.

The CERES project was to be a conversion of a Mercedes Sprinter, but it was first necessary for the conversion team to gain some knowledge about the process. This came from the conversion of another van to AC drive, a Citroen Berlingo. That conversion is described here, along with the lessons learnt for the Mercedes Sprinter conversion.

Contributors to the conversion

The Citroen Berlingo project was fortunate to have a team of technical experts with excellent knowledge of many of the fields required for a conversion:

- Bryce Gaton (electrician and ex-head of Electrical Trade and Renewable Energy department, Swinburne TAFE, Wantirna)
- Rhys Freeman (coordinator of previous CERES conversion)
- Simon Dodd (aircraft maintenance engineer at Qantas)
- Andy McCall (electrician and qualified motor body builder/repairer).

Funding and budgets

This project was not funded by CERES, but by an external source, Grow Lightly South

Image: Jennifer Hamilton, *Milk Magazine*, Gippsland

↑ EVs are suitable in rural areas and for delivery vans, so long as you work within their range limits.

Gippsland. The total budget was $35,000, though in the end the cost was closer to $40,000. Most of the extra costs were due to minor component/wiring costs.

Components and choices

The van chosen was a 2002 Citroen Berlingo. It had a damaged gearbox with significant oil leaks, and a noisy engine, also with persistent oil leaks. The vehicle had obviously been involved in an accident in the past, though the body had been adequately repaired, and it was apparent that the vehicle had been run without oil for months.

We believe that this vehicle would have been destined for the scrap heap if we had not purchased it—repairing these problems would have cost more than the vehicle was worth.

The existing engine did not matter at all and was removed. However, the gearbox was another matter. Simon pulled the gearbox apart and replaced the bearings and seals. This seemed to repair the leaks and removed the noise. He also completely removed the reverse gear, as reversing in the EV would be performed by reversing the motor direction.