

# Armstrong-Mobbs Sustainable House

Michael Mobbs



**Figure 1:** The Sustainable House is situated in the heart of inner-suburban Sydney – its new addition is clearly visible in the bottom right corner of the photo.

## ABSTRACT

The Armstrong-Mobbs Sustainable House is a celebrated case study of sustainable refurbishment of an inner-city terrace house. The owners, Michael Mobbs and Heather Armstrong, went to unprecedented lengths to integrate energy and water saving systems into their Sydney residence. Their aim was not only to minimise their home's environmental footprint, but to prove that a house that significantly reduces its adverse effects on the physical environment does not have to look unusual or be operated by experts.

*This note was originally published in 1998 as CAS 21. Its authors were Deo Prasad and Jason Veale. Its publication coincided with the publication of the first edition of Michael Mobb's Sustainable House book. The current version was reviewed by Michael Mobbs in September 2011. It follows the publication of the second edition of Sustainable House and incorporates the learnings from an additional 14 years of operation.*

## PROJECT DETAILS

**Address:** 58 Myrtle St Chippendale Sydney

**Clients:** Michael Mobbs and Heather Armstrong

**Project architect:** Peter John Cantrell and Alex Tzannes Associates

**Structural/Civil:** James Taylor and Associates

**Landscaping:** Sue Barnsley

**Risk Analysis:** Jim Irish, Insearch Pty Ltd

**Cost-Benefit Analysis:** Tony Abrahams, School of Accounting, UNSW

**Project Cost:** \$165,000 (1996 dollars)

**Cost of energy, water and waste systems:** \$48,000 (1996 dollars)

**Year of Completion:** 1996

**Building Area:** 150 square metres

## LOCATION AND CLIMATE

A terrace situated in a relatively quiet back street of an inner suburb of Sydney with three of Sydney's major roads, City Rd, Cleveland St and Broadway, less than 200m from the house. Of considerable advantage to the achievement of the project's energy-saving goals was the fact that the rear of the 5m wide terrace faces almost directly north.

Sydney experiences a moderate climate. The average daily maximum temperature in summer is 25.5°C, while the average daily minimum temperature in winter is 8.6°C. There is an average annual rainfall of 1315 mm and 142 rain days per year.

## Introduction

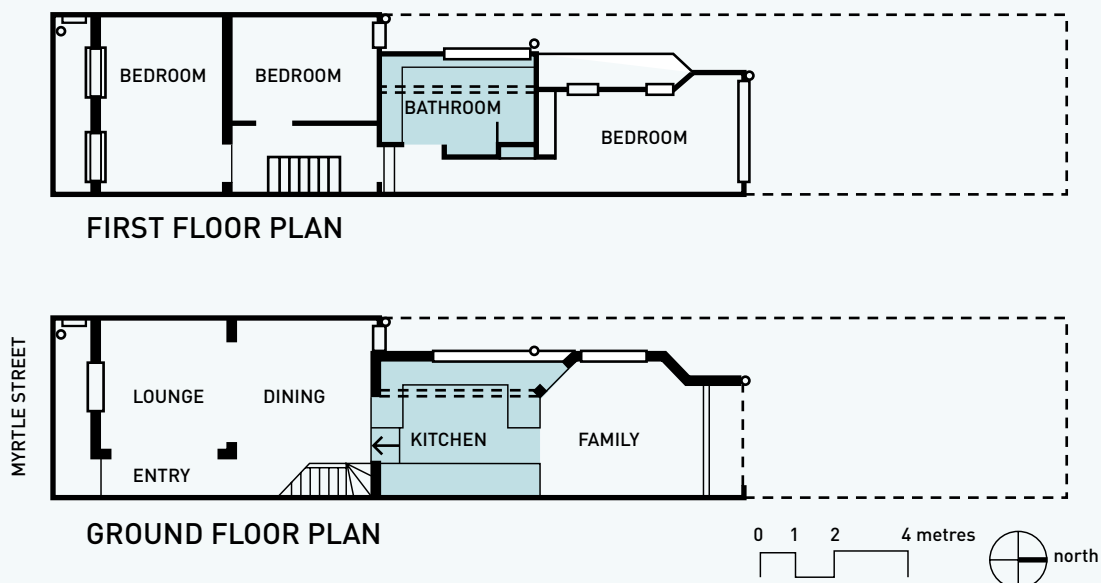
This terrace, in inner Sydney, probably has one of the greatest claims to genuine sustainability in Australia. This project owes its success largely to the perseverance of the clients in bringing together emerging environmental technologies and the various project parties. To achieve such low environmental impact with relatively untested techniques and technologies was a challenging task.

The house was originally purchased in 1979, its north-facing rear considered an advantage to good passive solar performance. The project started humbly with plans for a refurbished kitchen and bathroom, and ballooned into an exercise in self-sufficiency. Four years of research preceded the integration of water and energy saving systems.

It is the integration of these systems that gives the house its claim to sustainability. This project shows that a house that significantly reduces its adverse effects on the physical environment does not have to look unusual or be operated by experts.

A small degree of financial assistance was given to the project by the NSW Government and by suppliers in the form of discounts. Many of the suppliers and manufacturers took the opportunity to test and gain exposure for new products. The opportunity to have energy, water and waste conservation equipment fitted to a 'normal' house was considered to have significant marketing potential for the push into mainstream housing in Australia.

**Figure 2: Floor plans of the Sustainable House. New work shown shaded.**



## Project Management

The initial six goals for this project were:

1. No stormwater to leave the site
2. No sewage to leave the site
3. Collect sufficient potable (drinking) water on-site to meet resident requirements
4. Be a net exporter of electricity over 12 months
5. Use recycled or sustainable materials wherever possible
6. Minimise waste

Goals five and six in particular led progressively to the development of a client/architect/builders partnership. The following project management techniques helped to determine the nature of this partnership:

1. Inclusion of environmental goals and benchmarks into claims of progress. The builders had to demonstrate that a reasonable attempt was made to achieve set targets and goals, such as no waste leaving the site, before the progress claims were paid.
2. Design meetings between client, architect and tradespersons assisted with problem solving on a small site where many features were to be integrated.

## Sustainability Systems

The construction of a new bathroom and kitchen incorporated some simple passive solar techniques. However, what set this project apart from other urban retrofits are the waste, water and energy systems that are used in the house. It is these systems that make this house innovative.

### Passive Solar System

The new western wall of the bathroom and kitchen were heavily insulated with R3.5 natural wool insulation

batts, reducing the heat transfer of low western sun through to these spaces. The roof of the bathroom was also insulated with the same wool insulation.

Glass louvres were fitted to the new kitchen windows to allow greater air circulation through the ground floor of the narrow terrace.

Horizontal shading devices were not permitted to extend the full width of the rear glazing due to their extremities shading neighbouring properties. The central section of glass has been shaded to reduce the heat build-up in the northern bedroom and the kitchen. Two grape vines were grown along a trellis which runs the whole length of the exposed wall and a vertical garden was built on a two square metre section of the most exposed part of the western wall.

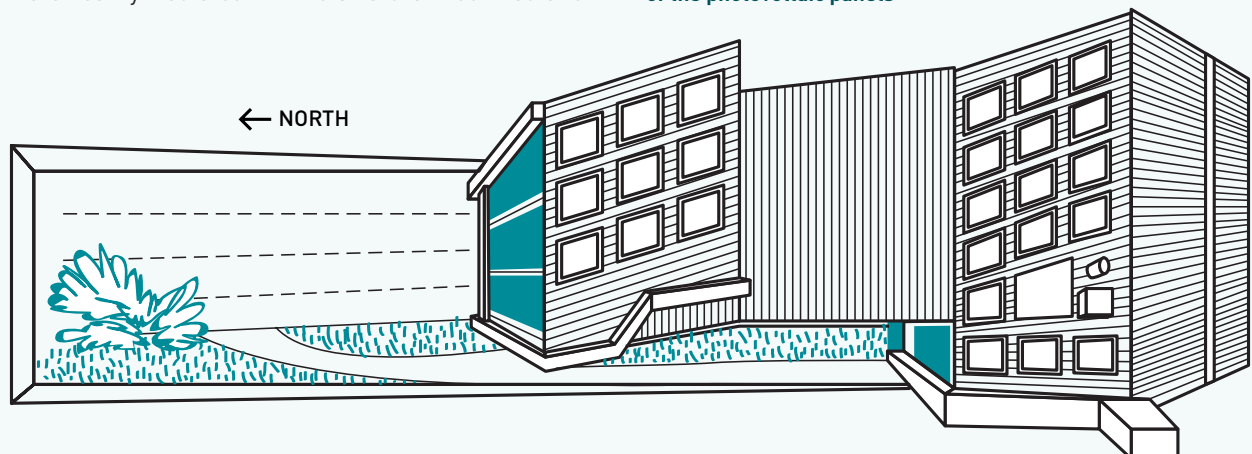


Figure 3: The refurbished kitchen

### Energy System

Eighteen 120 Watt solar panels (totalling just over 2kW) sit in two banks on the roof. The pitch and orientation of the roof allowed for a high degree of efficiency without pitching frames. An inverter, provided by the now-defunct Sustainable Energy Development Authority, allows energy from the panels to be fed into the electricity grid.

Figure 4: A birds-eye view of the roof showing the positioning of the photovoltaic panels



Compact fluorescent lighting and energy-efficient appliances were used in the refurbished kitchen and bathroom. Early indications were that the house would put more energy into the grid than it would require over a full year. But after two years it became clear the system was delivering about 20 per cent less power than had been predicted. Inspection by experienced solar installers revealed the system had been wired to function at the least efficient level of the least efficient panel. Thus, when three panels were partly overshadowed during the first four hours of morning sunlight, the remaining 12 panels would only generate as much power as the three inefficient panels. Those three panels were relocated to a sunnier position and the system has since produced as much as or more than the house uses. With the higher feed-in tariff for clean energy, however, the system is 'in front'; in August 2011 the power utility owed the owners over \$400.

The house hot water is powered by the sun with a gas booster, which is usually turned off.

A solar-powered fan ventilates the sub-floor to reduce rising damp exacerbated by the sandstone footings.

The total energy use of the house fell from 24kW/day to 6kW/day after the refurbishments and energy efficient appliances were fitted. Further efficiencies, mainly a more efficient fridge, have since brought the daily use down to around 4kWh a day.

## Water and Waste Systems

Water is collected from the roof and diverted via SmartFlo gutters, which prevent large material from entering the downpipe, into a 10,000L water tank under the rear deck. The first 25L of water are collected in a dummy pipe to prevent smaller dirt particles from entering the tank. The filter at the base of the dummy pipe requires periodic cleaning – a fine mesh filter is easily removed and cleaned. This is the only regular maintenance requirement of the potable water system.

An on-demand pump, located at the back of the garden, pumps potable water up to the house for drinking, showers and dishwashing.

The Faculty of Engineering at the University of Technology Sydney monitored the waste and potable water 18 months and found they the minimum standards set by the National Health and Medical Research Council.

All 'black' and 'grey' water and compostable waste from the house were transferred to a Downmus Composting Wastewater Treatment steel tank. However upon examination the system was found to have been poorly designed and built, and a new aerated waste-water treatment system was installed.

A lamp emitting UV light kills any bacteria in the water. The sterilised water is then pumped back to the house for flushing the toilet and washing clothes and for irrigating the garden.

An average daily excess of water from either system overflows into a buried pond and leaky drain buried about a metre down. Consequently, over 1.5 million litres of sewage has been kept on the site; there is mains water and sewer but the house is disconnected from both and pays no fixed charges.

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In the last 15 years, only once has the system reached maximum capacity, when approximately 100L of stormwater overflowed into the stormwater drain behind the house.

Soil tests show the subsoil will handle another 20 years of treated sewage.

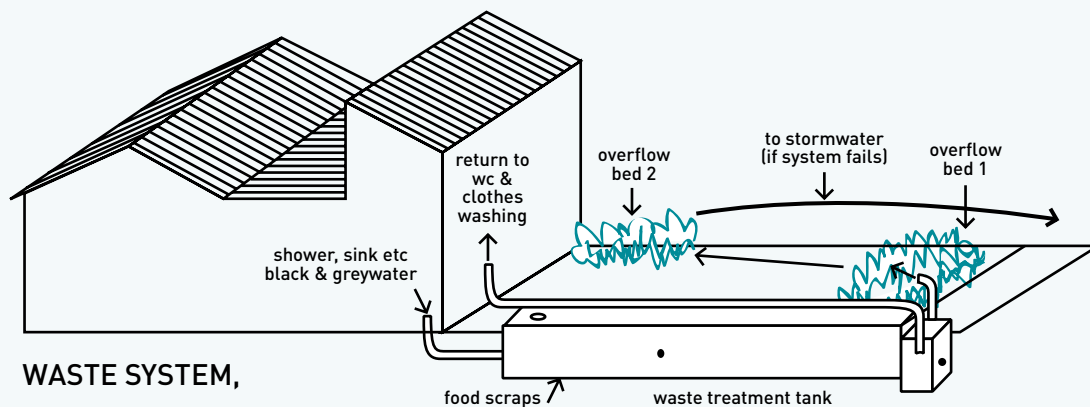


Figure 5: Sketch of the grey and black water system



## Materials and Products

No new or custom components were made for the house. The aim was to use products available in Australia to show that these systems had a broad application to the domestic situation. The bulk of the research time preceding construction was taken up with locating manufacturers and suppliers. Certain manufacturers were individuals developing their ideas on a part-time basis.

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### **timber was cut using a radial saw technique that uses approximately 45 per cent more of the cut log than conventional methods.**

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The kitchen fit-out provided the greatest challenge for the goal of low environmental impact of building materials. The new timber floor and external deck are constructed of hardwood sourced from regrowth flooded gum forest from the north coast of NSW. The timber was cut using a radial saw technique that uses approximately 45 per cent more of the cut log than conventional methods. The floorboards were finished with low toxicity tung oil. Cabinets are constructed of plantation-grown hoop pine and low toxicity, moisture-resistant, high-density particle board. Some PVC was used in the plumbing due to the unavailability of a suitable replacement.

## Cost-Benefit Analysis

The clients commissioned Tony Abrahams of The University of NSW School of Accounting to undertake a cost-benefit analysis of the project. Using unaudited data supplied by the clients, Abrahams found that, given the constraints presented by the site, and in terms of current technology and pricing structures, the exercise was not economically attractive. Based on the further assumption that the capital equipment had a life span of 20 years, the net present value (NPV) was determined to be almost -\$31,000. If the excess capacity of house were used to service the neighbouring house, then this figure improves to approximately -\$19,000.

With a new house on a 'greenfield site', the NPV of a project with similar aims becomes positive. The cost-benefit analysis estimated that this value would exceed \$18,000 and rise to almost \$30,000 on the basis of the excess capacity being used to service another building.

Recurrent annual savings of more than \$1100 were projected for the house.

A wide-scale use of these relatively simple systems provides a great opportunity to make savings on costs

of public infrastructure and consumption. Government and utility company subsidies to stimulate their uptake could produce significant environmental and cost benefits within a relatively short time frame; especially in the area of potable water supply and the avoidance of new power stations.

Since the renovation, the price of gas, water and sewage and energy have increased by a factor of four. These price increase meant the house's savings paid for themselves in 12 years. Presently four people may live in the house and pay less than \$300 for energy, water and sewage. The electricity retailer currently owes the house over \$400 for the clean energy sold back to the grid.

## Indicators of Sustainability

A suitable indicator of sustainability is to analyse the goals set by the client for their success. The following information on the operation of the systems was provided by the client. The text in italics is information provided by the client based on extrapolation from the measurements recorded by metering equipment (solar inverter, water usage and progress claims), and on information provided by SEDA. The numbers in that text illustrate the benefits of the house and its systems to the environment every year (the numbering refers to the goals outlined previously).

1. Almost all stormwater has been retained on site. This keeps more than 80,000L per annum of stormwater out of Sydney Harbour. In 14 years over 1.5 m litres of stormwater has been kept on site and out of the harbour.
2. No sewage has left the site. The client made a permanent disconnection from Sydney Water to avoid maintenance fees. This keeps more than 60,000L per annum of sewage out of the Pacific Ocean. Over 1.5 m litres of sewage has been kept on a site of less than two square metres.
3. With the installation of water saving-appliances and equipment, and a conscious effort by the client to conserve water, the daily water usage has dropped from 310L in 1995 to 230L 12 months after completion of the work. Thus, the average daily water use at the house is 57 litres per person compared to an average of 247 litres for mains water consumers.  
Since becoming reliant solely on the potable water tank, the clients have 'bought' 4,000L of water from the municipal supply (by hose from their neighbours). This saves 102,000L of water per annum, which is left in the Shoalhaven River and Warragamba Dam.

4. To date, the solar panels have supplied more power during the day than has been used at night from the grid. This produces \$1,119.30 of clean energy a year, or \$3.06 a day and saves the burning of 4.3 tonnes of coal to produce mains electricity.
5. Recycled and plantation timbers and low toxicity materials were used wherever possible, with the exception of some unavoidable PVC.
6. Certain sections of the ground floor were replaced, with the old boards being used elsewhere in the construction. Bricks taken off the site were recycled. While an attempt was made to keep waste to a minimum the combined team were unable to avoid a small amount of waste going to landfill.

An additional factor contributing to these energy, water and waste conservation figures has been the Armstrong-Mobbs family's increased knowledge of environmental issues. Each member of the family, including the two children, is more aware of the relationship between their behaviour and lifestyle and the demand for energy and water and the production of waste. Only equipment that either operated automatically or required simple user interaction was chosen for each system. The family did not have the time or skills to operate complex systems. User-monitoring of potable water levels, energy production and consumption have aided the overall reduction in energy and water consumption because of the direct nature of the link.

## Application to Other Urban Sites

The photovoltaic system fitted to this house benefited from a large roof area facing north. A terrace house with east or west street frontage would require an additional structure to face solar panels north and thereby maintain peak efficiency. New houses could be designed to allow a sufficient roof area facing north. However, the rectilinear forms of most Australian housing would disadvantage sites not facing directly north, south, east, or west.

Cost was also not as significant a restraint for this client as may be the case for other homebuyers. The goal of sustainability, which has been already largely achieved, was considered greater than a short payback period. While the cost-benefit analysis demonstrates the potential appeal of these systems for new house sites, the cost of water supply, electricity supply and sewage removal are determining factors for existing sites. If the costs of public infrastructure were to increase significantly, as they are projected to, these systems are certain to become more popular.

Since the house was built, sustainable design and systems have come to occupy local, state and federal government policy at a mainstream level. Millions of dollars in government rebates and incentives are allocated to citizens to install solar electricity systems, hot water systems, rain tanks and insulation.

These incentives have brought some prices down, while others have stayed much the same. For example, an equivalent capacity solar electricity system today costs about a sixth of the cost in the house's system in 1996. But solar hot water heaters remain expensive; it seems to the author that the rebate for them has simply added to their cost.

It is possible to spend about \$20,000 now and get that repaid in five to 10 years, with the payback period continually shortening as the cost of energy and water increases.

## Conclusion

The main value of the house, besides its sustainable features, is its ordinary appearance, which persuades many people to copy it. The lessons learnt, the successes and failures of the project make the house a useful reference point for householders wishing to go sustainable, as well as for builders, designers and policy makers.

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## References and Further Reading

*Sustainable House*, 2<sup>nd</sup> Ed, Michael Mobbs, 2011, UNSW Press

Sustainable House blog,  
[www.sustainablehouse.com.au](http://www.sustainablehouse.com.au)

ABC Science case study:  
[www.abc.net.au/science/planet/house/default.htm](http://www.abc.net.au/science/planet/house/default.htm)

There is a model of the house in the NSW Powerhouse Museum permanent exhibition 'Ecologic'

## About the Author

Michael Mobbs is a former environmental lawyer who now works as a sustainability coach and speaker, urban farm designer, major projects consultant, and residential sustainability consultant.

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