DIY GENERATION

The coal-fired electricity grid is hugely inefficient. Distributed electricity networks, on the other hand, are coming, linking each home or building as a lean power station, and helping to curb Australia's greenhouse emissions. **Rachel Sullivan** reports.

Solar panel installations and state-based feed-in incentives are helping form a precursor distributed energy network. Jim Puritt, iStockphoto

Australia's standard but generous housing design has traditionally tended to encourage high-energy use because space has been a luxury and electricity has always been so frivolously cheap.

But with power bills set to rise and the growing take-up on doing more to reduce greenhouse gas (GHG) emissions, there is increasing interest in localised power generation – that is, turning existing buildings into mini power stations and feeding the excess power back into the grid.

Already widespread throughout Europe, Japan and the US, micro-generating devices include roof-mounted photovoltaic cells, solar hot water systems, small wind turbines, natural gas or biogas powered generators, and even mini hydro systems that generate power from local water sources. They collectively form part of what is known as a distributed energy (DE) network and are often also associated with demand reduction measures.

'Micro-generation and the establishment of distributed energy networks represent a shift in thinking away from the traditional model of big centralised power stations,' according to energy expert and Director of Invenergy, Dr Tony Vassallo. He says that if small-scale generators were installed in sufficient numbers they could have a significant impact, helping to slash carbon dioxide emissions, and take the strain off overloaded distribution grids, particularly during periods of peak demand.

In the UK, the distributed energy concept is being taken very seriously: combined with reduced demand, over the next 20 years it is expected to provide up to a third of London's power needs.

But, in Australia, given the proliferation of energy-consuming devices and our insatiable demand for power, can embedding micro power stations into existing buildings really help reduce reliance on coal-fired power generation?

The new frontier

For some parts of Australia micro-generation is already at the heart of a grassroots community revolution. In Tathra, on the far south coast of New South Wales, for example, the community came up with a target of reducing their energy consumption by 50 per cent by 2020, as well as producing 50 per cent of their energy needs from renewable sources. With the local council on board, everyone from the surf club to churches, schools and fire brigades has started installing solar panels and wind turbines to produce their own power, by fundraising for the initial installation and then putting the money saved to good use.

Meanwhile in Sydney, Lord Mayor Clover Moore recently announced a plan for the City of Sydney that would slash energy use by decentralising electricity generation and powering entire blocks with natural gas powered 'Green Transformers', aimed at not only cutting Sydney's greenhouse gas emissions but also offering protection against blackouts.

Known as cogeneration, this process, which is well suited to office towers and apartment buildings, uses waste heat associated with the generation of electricity to heat water and cool buildings, further reducing the city's energy demands.

Rob Helstroom, Principal Scientist with sustainable energy consultants Kinesis, helped develop the cogeneration strategy for Sydney City Council, and says that building the power source close to its end use is just commonsense. 'Locating the power plants in the city would reduce the huge amount of available energy that is lost

when electricity is produced by conventional, large-scale power stations, remote from the user. Cogeneration can harness at least 80 per cent of the energy in the fuel compared to just 35 per cent for coal-fired power generation.'

Modelling by Kinesis showed that the gas-fired plants could generate about 330 megawatts of electricity from natural gas and, when combined with demand reduction measures, could provide 70 per cent of the city's power requirements by 2030.

Despite being part of Sydney's 2030 vision, several large developers have already seen the light and are intending to use the technology in mixed-use precincts around the city, including the Carlton United Brewery redevelopment on Broadway, and the new Barangaroo development in east Darling Harbour. The first of those should be up and running within three years, while the Powerhouse Museum in Ultimo has already teamed with its neighbour, the new Ian Thorpe Aquatic Centre, to use gas to generate power for the museum and to warm the pool using the cogeneration heat.

If small-scale generators were installed in sufficient numbers they could have a significant impact, helping to slash carbon dioxide emissions, and take the strain off overloaded distribution grids, particularly during periods of peak demand.

Overcoming the barriers

Until now, however, widespread uptake of distributed power generation in Australia has been frustratingly slow, despite often locally designed products such as grid-connected photo-voltaic panels being readily available. It would require about a million homes feeding power into the grid to offset the need for one power station; by the end of the federal government's Solar Cities program, there will be around 10 000, with annual growth of around 15 per cent.

One of the major barriers to average consumers installing their own system is cost. Even with current government rebates it can take up to 20 years to recoup the investment in a PV system, for example. Overseas, where the number of grid-connected micro-generation devices is growing at around 50 per cent per annum in some countries, consumers are offered an incentive to make the switch – they receive a premium known as a 'feed-in tariff' for the excess power they produce. South Australia has recently become the first Australian state to offer a feed-in tariff, with some other states considering similar arrangements to encourage more grid-connected systems.

The sun may be setting on our faithful but inefficient and expensive centralised grid infrastructure. Danish Khan, iStockphoto

Energy needs are predicted to continue rising and, based on current projections, it is unlikely that distributed energy generation alone will be enough to reduce our dependence on centralised power production, according to Dr Luke Reedman, an economist at CSIRO's Energy Technology division. 'With no change in current policy settings, our economic modelling indicates that local power generation could increase from its current low base to around 10 per cent of total electricity generation by 2050.'

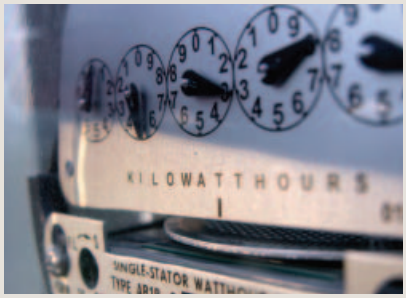
But under an emissions trading framework, the economics of distributed power generation improve considerably and the investment becomes more attractive, he says. 'Our results show that with a greenhouse gas emission reduction target of reaching 60 per cent below 1990 levels by 2050, uptake of distributed energy generation will theoretically increase to around 20 per cent of total electricity generation by 2050.'

'By 2050, this is equivalent to around 50 million tonnes of CO_2 abatement per year

Peak load

Coal-fired power plants have been designed and interconnected across states so they can meet the peak demand without blackouts on the relatively few days per year when demand spikes – for example, when the temperature reaches the high 30s or low 40s and everyone turns on their air conditioning units at the same time. However, in terms of converting the energy available in the fuel into electricity, any conventional power station is very inefficient and wastes most of that energy as low grade heat.

According to energy expert Dr Tony Vassallo, the best modern coal-fired power stations are 30 per cent efficient. More than 60 per cent of the fuel energy is wasted as heat in cooling towers and in



Chad Truemper, iStockphoto

the exhaust from the chimney stacks. A further 8–10 per cent is lost in transmission. That means a total of 70 per cent of the energy contained in coal when it is burnt is wasted because there is simply no use for it so far from town.

when compared with business as usual. This does not include additional abatement from deployment of non-generation distributed energy options such as solar hot water and intelligent energy management systems.'

Smoother operators

Even with growing interest from the wider community, building a distributed energy network is not as easy as buying a wind turbine, plugging it in and – *voila*! – free power.

One of the main concerns with the proliferation of micro-generation devices is that having so many small units feeding power into the grid will cause instability through voltage fluctuations. However, studies have shown more stability in grids with distributed power generation – they help alleviate congestion, and output can be much more readily increased or reduced than with large-scale energy generation systems.

'Like the myriad pathways of the Internet, or a well-functioning road network, there is also great strength in diversity,' says Dr Vassallo. 'If one route is shut down for any reason, then traffic flows onto an alternative pathway, with minimal disruption. It is the same with the power grid.'

'The grid's reliability will actually be improved because a distributed energy network removes the large central points of failure,' agrees Dr Glenn Platt, Project Leader, Intelligent Energy at CSIRO.

'To facilitate this, the government has established the Ministerial Council on Energy, a working group on renewable and distributed generation, which is developing a code of practice for local generation, grid accessibility and network incentives. Rule changes from this process should also provide a more level playing field for DE, and open the way for new entrants into the market.'

Although an investment in a micro-generating device may take years to pay for itself, those who have made the decision couldn't be happier. And with new technology being developed all the time and economies of scale likely to see prices continue to fall, these devices will become an increasingly viable and important part of our homes, apartment blocks and office buildings.

This 'cogen' gas generator, installed on an apartment tower in NSW, produces both electricity to serve some of the building's common areas and also approximately 50 kW of heat for domestic hot water. Conventional power stations, remote from the city, waste much of their heat. Kinesis Pty Ltd.

Even power companies, which might be considered the natural enemy of DIY electricity, are involved in trial projects in distributed energy generation and developing improved control technologies. They are currently working with CSIRO on a project called the Intelligent Grid, which is about making DE work from an economic, practical and social standpoint – such as safety, noise and pollution – and about getting the community on board through improved public awareness programs.

So while DE might not replace coal-fired power generation in the foreseeable future, Dr William Lilley, Project Leader on the Intelligent Grid project, says that distributed energy generation has a lot going for it. 'By being much more responsive, it is the most logical mechanism to tackle peak load growth, which is generally location specific and occurs for a small number of hours each year.'

It is also giving consumers the power to cut greenhouse gas emissions and reduce our impact on climate change now, using existing technology, he says. 'If we can get these [micro-generating devices] into the system, we can start to tackle climate change now while new technologies such as carbon capture and storage … are being developed, a process that could take years to perfect.'

More information:
Ministerial Council on Energy, www.mce.gov.au

CSIRO Intelligent Grid, www.csiro.au/science/IntelligentGrid

New power technology

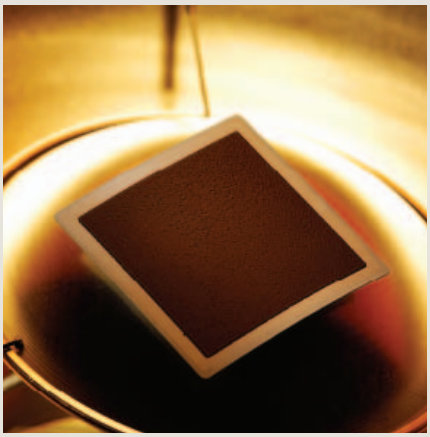
People could live in glass houses and look at the world through rose-tinted windows while reducing their carbon emissions by 50 per cent, thanks to Queensland University of Technology (QUT) Institute of Sustainable Resources (ISR) research. The ISR, alongside a Canberra-based company, Dyesol, is developing transparent solar cells that act as both windows and energy generators in houses or commercial buildings.

'The glass captures solar energy which can be used to power the house but can also reduce overheating, reducing the need for cooling,' says QUT Professor John Bell. It is even possible to build houses made entirely of the transparent solar cells.

'The transparent solar cells have a faint reddish hue but are completely see-through,' he says. 'They contain titanium dioxide coated in a dye that increases light absorption.'

'But it is easy to build a house that doesn't need powered cooling or heating in Queensland.'

Meanwhile publicly listed Ceramic Fuel Cells Limited, formed in 1992 to commercialise technology originally developed at CSIRO, has become a global leader in fuel cell development with customers and appliance partners in the UK, Germany, France, Holland and Japan.



A solid oxide fuel cell. Ceramic Fuel Cells Ltd.

Fuel cells convert gas (from mains or bottles) into electricity and heat, without combustion or noise, but with very high efficiency and low emissions.

The company's first product is a combined heat and power (m-CHP) unit to provide clean power and heat for homes. It connects to the existing natural gas network and exports excess power to the electricity network. Each home unit can save up to three tonnes of carbon dioxide emissions per year compared to coal-fired power.