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Towards a Solar City:

Expanding solar photovoltaic (PV) electricity usage in the Darwin area

Ella McHenry and Gary Scott examine the potential for solar photovoltaic electricity in Darwin.

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What is the potential for households, businesses or community organisations to utilise solar photovoltaic systems in the greater Darwin area?

Geographically, Darwin is well situated to utilise the sun to generate electricity. In fact, Darwin receives almost twice as much sun as the world's solar capital Germany which accounted for 57%[1] of the world market in 2005. Consequently, there is enormous potential for households, businesses and community organisations in the greater Darwin area to take advantage of available solar photovoltaic (PV) technology to generate electricity.

Indeed, following on from the current bid by Alice Springs to become a Solar City, Darwin and its neighbouring city of Palmerston could both become Solar Cities by 2010 if political leaders and the local community have the determination to make it happen.

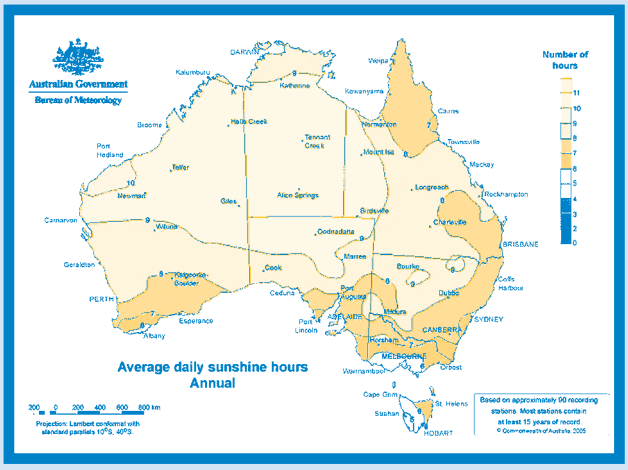
Certainly, the uptake of solar technology in remote NT communities through programs such as Bushlight demonstrates that it is feasible for households and businesses in the greater Darwin area to generate a substantial amount of their own electricity from photovoltaic sources. Over 200 communities and almost 140 pastoral properties in the NT have installed solar systems under the federally-funded Renewable Energy Rebate Program[2]. In Melbourne (again a less favourable 'solar zone' than Darwin[3]), Stuart McQuire and Wendy Orams have generated more electricity than they use from their household PV set-up for the past 10 years and sell surplus energy back to the Victorian grid (though the house uses gas for cooking, heating and hot water boosting)[4].

Meanwhile, at least 40 percent of NT households already have a solar hot water system on their roof[5], compared to just 8 percent nationally[6]. Converting from electric water heating to solar can reduce an average NT household's greenhouse gas emissions by about three tonnes per year[7]. As well as expanding the use of PV technologies, there is scope to further increase the uptake of solar hot water heaters in Darwin and Palmerston through well-targeted territory and federal government incentives.

What is a solar photovoltaic system?

A solar photovoltaic system uses light to generate electricity. Photovoltaic (solar) cells are usually made from layers of crystalline silicon doped with phosphorous or boron. Phosphorous has more electrons than boron, so the doping produces one crystal with more electrons than the other, which are called N-type or P-type silicon respectively. When brought together, charged particles (electrons) move from one layer to the other. This creates an electric field between the layers and is called P-N junction. When energy particles in the form of photons (sunlight) strike electrons near the junction, electrons are released (photoelectric effect). The electric field at the P-N junction makes these electrons move across the border between the layers. Since an electrical current is made of moving electrons, it can be said that light is converted directly into electricity.

http://www.sustainable.energy.sa.gov.au/pdfserve/advisory/regional/pvrp/pdf/0203a.pdf



Why has the uptake of solar PV technologies been so poor in the Darwin region?

Despite favourable geographic conditions in the Northern Territory (see the map showing average daily sunshine hours in Australia), it is really only in remote settings that solar photovoltaic systems are being utilised. Urban areas have thus far failed to implement real changes to reduce greenhouse gas emissions through the use of photovoltaic technologies. Nationally, most PV systems installed to date have taken advantage of the Federal Government funded Photovoltaic Rebate Program (PVRP), which began in 1999. Statistics as to the number of users who have taken advantage of this rebate are telling[8]. When population is taken into consideration South Australia has by far the highest uptake of PV technologies with one grid connected system for every 790 people. NSW and Victoria are comparable with one PV system per 2444 people and 2016 people respectively while in the NT there is only one grid connected PV system per 13 246 people — a total of just 15 systems. However, as previously pointed out, the uptake of non-grid connected solar PV systems (see box for an explanation of grid-connected systems) and solar hot water heaters in the NT has been more significant.

There are a number of factors which may have influenced these trends:

- By far the biggest impediment to the expanded use of PV systems is their cost. A small PV set-up, which would contribute towards average household energy usage in the greater Darwin area would cost up to $15 000 to install. For an average household to generate as much power as they use could cost in excess of $25 000. Providing the eligibility criteria for the Photovoltaic Rebate Program were met, up to $4000 of federal funds would be available to contribute towards the set-up. The expense of PV systems has meant that power providers and community groups have tended to look at ways of reducing greenhouse gas emissions which rarely include PV technology.
- Darwin has an unusually high percentage of rental homes. In 2001, 40.8% of dwellings in Darwin were rented[9]. As the PV rebate is only available to householders installing PV systems in their primary place of residence, a large percentage of Darwin's population is automatically ineligible.
- The population of the Northern Territory is extremely mobile. In 2001, gross moves in the NT numbered 171 000 — almost equal to the total population. This gave the NT a population turnover of 89% in comparison to 14.6% in Victoria and 15.6% in NSW[10]. As the installation of a PV system requires a considerable financial outlay initially, it seems logical that regions with more stable populations would have a higher rate of investment in PV technology.
- Electricity costs vary across Australia. As the cost of electricity in Darwin is less than in some southern states, it would take longer to recoup the costs of installing a PV system in Darwin than Adelaide, for example. Further, as excess energy generated from a domestic PV system is sold back to the grid at the local market rate, households selling electricity generated by solar power back to the grid in some southern states would receive a higher rate than their counterparts in the Northern Territory. The South Australian and Victorian governments have recently made commitments to introduce an electricity Feed-In Tariff. The tariff will offer householders with grid-connected solar PV systems a premium rate for the electricity they feed into the grid. In the South Australian case householders can receive up to twice the standard rate at peak demand times[11].
- Information is generally easier to access elsewhere than in Darwin. Large energy providers such as Origin Energy have made information regarding PV systems and the associated rebate easily accessible via retail stores and well designed websites which promote the uptake of PV technologies[12]. The accessibility of online information for Darwin residents has at times been made more difficult by the regular rounds of departmental restructuring that have taken place in recent years. However, in 2005 a website called 'Make the Switch' was developed by the NT Department of Primary Industries, Fisheries and Mines (DPIFM)[13], which provides a central access point for information

What does 'grid interactive' mean?

Grid interactive systems are connected to the electricity supply grid. Grid connected systems are generally located in urban areas and (solar) PVs are the usual energy source. The main components of the system are the renewable energy source and a grid interactive inverter.

The inverter converts the low DC voltage generated by the system to the normal 240V AC household supply. It also monitors the operation of the system to control how much electricity is drawn from or fed to the grid.

If the system is supplying more energy than is needed, the excess is fed into the grid. Often the meter just "runs backwards" when electricity is going into the grid, so the household only pays for the difference between what is imported and what is exported. Different suppliers have different buy-back rates and metering arrangements. Check with your electricity supplier for precise details.

System sizing is not critical as the grid is used for backup when the system output is insufficient for household needs.

As a rule of thumb, a one kWp monocrystalline array will produce about 1,500 kWh of electrical energy per year and will require nine square metres of space. An amorphous system will require more space. The system designer will specify and size it accurately for your particular location and load.

As the peak output of the system is determined by the size of the inverter, it can be useful to install a larger inverter than initially required. The excess capacity will allow additional modules to be added later. The size of the inverter will depend on your budget.

Grid connected systems do not have storage batteries and do not provide a guaranteed continuous power supply. If the grid goes down the inverter will cut out for safety reasons.

http://www.greenhouse.gov.au/yourhome/technical/fs46.htm

about the Renewable Energy Rebate Program, as well as the relevant application forms for the Photovoltaic Rebate Program. This is a useful site but should be given greater prominence on the NT Government and DPIFM home pages. The information on the PVRP could also be given greater prominence on the 'Make the Switch' site. This observation also applies to the Power and Water Corporation's website, which has essential contracts that Power and Water requires their customers to sign in order to access the PVRP rebate.

- It is fair to say that communication about the PVRP rebate has been somewhat poor in Darwin. There appears to be a lot of confusion in the community as to who is eligible and many people believe rebates are only available to off-grid users of electricity since this is where the bulk of government funding and promotional activity has been directed. It does not help that the relevant forms to access the rebate are spread across two websites and organisations.

- The potential for households that purchase PV systems to sell Renewable Energy Certificates (RECs) to corporations such as Power and Water may be underutilised. Renewable Energy Certificates represent one megawatt hour of power generated by a small renewable energy unit such as a domestic PV system. The Commonwealth Government requires electricity retailers (and other liable parties) to purchase a certain amount of power from renewable energy sources so that they meet the mandatory 2% renewable energy target. This has created a market for small scale producers of renewable energy to sell the Renewable Energy Certificates their PV installation creates to companies needing to offset their liability under the Renewable Energy (Electricity) Act (2000). Currently Power and Water relies heavily on the installation of solar hot water heating to meet its 2% target, but there is concern that the solar hot water heater market may be increasingly saturated without further government financial incentives to householders. There is also the issue of how Power and Water would attain a higher renewable energy percentage target of say 10-20%, should one be mandated in future by either the NT or federal governments.

- The small number of PV system installers in Darwin may have led to a lack of competition amongst installers and therefore higher prices.

Roof-top solar PV and solar hot water heater in Palmerston.
Photo courtesy of NT Government.

What could be done to improve the uptake of these technologies?

Elsewhere, successful strategies for encouraging the installation of PV systems have included government subsidies for the installation of solar panels/systems (such as the PVRP), low interest 'green' loans for the installation of PV systems, and preferential tariff rates for green power generated by small scale PV applications, which have been very successful particularly in Germany[14]. To put these incentives into perspective: a PV system in Darwin would receive AU14.2c per kilowatt hour for selling the electricity it generates compared to the premium rate of roughly AU81c available in Germany[15]. German investment in renewable energy also has positive benefits beyond the reduction of greenhouse gas emissions, such as the creation of over 10 000 jobs[16].

Easy access to information regarding such incentives and important information regarding suppliers of PV equipment, use agreements and the like is also essential if energy consumers are to be encouraged to install PV systems. It is possible that energy consumers would be encouraged to consider PV systems more seriously if this sort of information were accessible and well promoted. Many energy consumers remain unaware of the options for generating renewable energy domestically which may have had an adverse effect on the uptake of PV technologies.

Ensuring that clear links are made between government initiatives such as the PVRP and the creation and sale of Renewable Energy Certificates (RECs) could also assist in the uptake of PV technologies. Interestingly, rates paid for RECs by (NT) Power and Water are higher than elsewhere in Australia giving the promotion of this scheme a significant incentive.

Adoption of a **Territory-level Mandatory Renewable Energy Target** would also improve the context for uptake of PV technologies. Other state-level governments have in fact already beaten a path for the NT Government to follow. The Victorian Government has legislated a renewable target of 10% by 2016; South Australia has set a target of 20% by 2014; whilst the New South Wales Government has committed to introducing a target of 10% by 2010 and 15% by 2020 if it is re-elected in March 2007[17].

Projects such as the Darwin City Council's proposal to install solar panels on the roof of the Civic Centre are also important as they raise public awareness of the potential for solar energy to contribute significantly to domestic power generation.

Solar powered air-conditioning

Air-conditioning can account for a quarter or more of a Darwin household's electricity use. Demand on the electricity supply system also increases during periods of very hot weather. This in turn increases the pressure on Power and Water to commission an additional gas-fired power station in order to cope with peak surges. Yet the developing technology of solar air-conditioning has the potential to provide a solution to this problem in coming years. For one thing, the increased electricity demand generally occurs when the sun is shining at its brightest.

The Royal Australian Institute of Architects (RAIA) has already called for the development and commercialisation of solar air-conditioning to be a central part of state and federal government plans to reduce greenhouse gas emissions. Solar air-conditioners can either run off rooftop solar panels or by using solar thermal energy to refrigerate water for a cooling effect. There are a wide range of technologies being developed overseas and one type of solar evaporative air-conditioner is currently being trialled in South Australia — see www.coolmax.com.au. Some of these different technologies will be more applicable to Top End conditions than others.

'Even the Pentagon in Washington has solar powered air-conditioning' — RAIA.

See www.archicentre.com.au/media/200631OCTWASolarRC.htm

Darwin and Palmerston as Solar Cities

Obviously the high initial capital cost of PV systems remains the most significant barrier for most households. In the course of developing the Alice Springs bid to become a Solar City a range of proposals were put forward that would have reduced the burden of this capital outlay. Solar Cities is a $75 million Commonwealth Government initiative designed to increase the usage of solar energy in a few selected Australian cities. By developing partnerships with a major PV retailer as well as a bank willing to provide loan assistance, the Alice Springs Town Council bid showed that with increased government financial assistance it is feasible to install PV systems in hundreds of Territory homes[18]. It was also proposed that an electricity Feed-in Tariff above the standard 14.38c per kwh be paid to participating households with grid-connected PV systems.

Whilst Alice Springs has not yet been confirmed as a Solar City, there is an expectation that it will become one in the near future. Darwin and Palmerston are prime candidates to become Solar Cities and a joint bid should be developed as soon as possible. One of the successful Solar Cities bidders, Townsville, a tropical city in northern Queensland of a similar size to Darwin, plans to install up to 1 MW of solar energy in 500 homes and businesses at no cost to the owner[19]. It will receive $15 million in Commonwealth funding in the process. When added to the planned 1 MW of installed solar capacity in Blacktown and the 2 MW in Adelaide — being the two other Solar Cities announced thus far — it is anticipated that the national initiative will reduce greenhouse emissions by more than 64,000 tonnes per year[20].

What impact would improved uptake of PV technologies have on the Northern Territory's greenhouse gas emissions?

The Australian Bureau of Statistics 2006 Yearbook states; "the bulk of Australia's energy related greenhouse gases were emitted in the production and consumption of goods and services for the purpose of household final consumption (about 56%)[21]." Household electricity alone accounts for 17% of Australia's greenhouse gas emissions[22]. Clearly, increased uptake of PV electricity generation could significantly reduce greenhouse gas emissions.

Stuart McQuire on the roof of his solar powered home in Melbourne.
www.greenmakeover.com.au/10yearssolar_ReNew_article.pdf

In the Northern Territory a large percentage of greenhouse gas emissions can be attributed to savannah burning (41%) but rising emissions from the energy generation sector (32%) continue to have a significant impact[23]. While not all energy generated is used by domestic, business or community groups, if hundreds of houses in the Greater Darwin area had a grid-connected PV system installed, greenhouse gas emissions would be substantially reduced. PV installations would be made much more effective if undertaken in conjunction with other energy conservation measures as promoted by community organisations such as COOLmob[24]. Taken together, a greenhouse gas saving of 3-4 tonnes per household per year is achievable. It should be pointed out that the greenhouse gas saving from PV installation is greater in cities like Adelaide and Townsville than in Darwin or Alice Springs as the former currently rely on more CO2 intensive coal-fired power generation rather than gas-fired generation.

A further consideration that needs to be taken into account is the projected future increase in electricity demand in the Darwin region and the potential requirement for a second gas-fired power station that may lead from this. A combination of energy efficiency and installation of solar PV technologies in Darwin homes, businesses and government buildings could well be a more cost-effective option than the construction of an expensive new power station, not to mention being more environmentally beneficial. Gas is a finite and non-renewable energy source.

Recommendations:

Some initial steps to improve the uptake of PV technologies in the greater Darwin area are as follows:

- **The NT Government should initiate and help to develop plans to make a bid for Darwin and Palmerston to be declared as Solar Cities**. If further Commonwealth funding is not forthcoming for this federal program then the NT Government should commit to making sufficient funds available.
- Adoption by the NT Government of a Mandatory Renewable Energy Target, backed by legislation that would significantly increase the target from the current federally-mandated 2%. This would put the NT in line with a number of other states.
- The NT Government should commission a detailed cost-benefit analysis of the cost-effectiveness, greenhouse gas, employment and social benefits of an expanded household and community PV solar program in Darwin/ Palmerston, together with a concerted energy efficiency program, compared to the construction of a second gas-fired power station in Darwin.
- Power and Water should introduce an electricity Feed-In Tariff in the NT, similar to the South Australian and Victorian initiatives.
- The NT Government and Power and Water Corporation should introduce a GreenPower scheme in the NT (see box on page 7).
- Solar hot water heating should be mandatory for new homes in the NT, together with increased incentives for the installation of solar hot water heaters on older homes and rental properties.
- The NT Government should investigate the feasibility and environmental benefits of installing solar air-conditioning in new government buildings and encourage their use in new apartment blocks.
- The NT Government and Power and Water Corporation should review how information about the Photovoltaic Rebate Program is presented on their respective websites and where necessary make changes to improve the public accessibility of this information. Improved information resources about the rebate program should be actively promoted to relevant stakeholders including schools, businesses, home owners and landlords.
- A meeting should be held to bring together various stakeholder groups to discuss available rebates and agreements regarding solar PV electricity provision. If there was a shared understanding as to existing procedures and opportunities, and improved networking between Power and Water Corporation, DPIFM and local government, the public would more readily be able to access information about PV systems and their potential.

Further initiatives undertaken by community groups could focus on:

- Lobbying financial institutions, councils or Territory government to consider green loans.
- Working with the Darwin and Palmerston City Councils to promote the uptake of renewable energy generation technologies in the region and increasing awareness of council schemes to this end.

While local measures such as these are important to the goal of encouraging greater utilisation of PV technologies in the greater Darwin area, there is also the need to maintain pressure on the Federal government to develop significant policy incentives for the development of PV and other technologies. Without measures such as a significant increase in the Mandatory Renewable Energy Target, there is little incentive for investment in the renewable industry[25]. Failure of the Howard government to acknowledge the real cost of the fossil fuel industry through the continuation of "perverse subsidies"[26] to the fossil fuel industry and the absence of a carbon tax also retard investment in renewable technologies[27].

However, if households, businesses and community groups in the greater Darwin area were provided with the necessary information, financial and logistical support and encouragement, a much larger number of grid interactive PV systems would be installed. Given how poor the uptake of these technologies has been it seems clear that current tactics for promoting photovoltaic technology have been largely unsuccessful. With a fresh approach to marketing the feasibility and necessity of increased use of solar PV systems, coupled with greater use of financial incentives in order to reduce the cost of installation, the community and government could have a greater impact on reducing greenhouse gas emissions the Darwin area. The aim should be for Darwin and Palmerston, along with Alice Springs, to become genuinely solar cities by 2010.

Useful NT Websites

Information about the Photovoltaic Rebate Program

Make the Switch (forms for the PV Rebate Program — see 'Other Programs' link):
www.maketheswitch.nt.gov.au

Power and Water Corporation (essential info about the PV rebate program):
www.powerwater.com.au/powerwater/business/photovoltaic_rebate.html

Community groups promoting solar energy in Darwin and Palmerston

Australian and New Zealand Solar Energy Society: **www.anzses.org**

COOLmob: **www.coolmob.org**

Buying GreenPower in the NT

If you do not have your own renewable power system, but are interested in offsetting the greenhouse gas emissions that your family produces, you may like to look at 'GreenPower.' Renewable energy such as wind, biomass, hydro or solar power is produced by a power company and sold on the open market (the same as normal electricity). Renewable energy is more expensive (a few more cents per kWh) to produce than 'black power' (normal fossil fuel power). GreenPower customers choose to pay more to subsidise the production of power from renewable sources.

To support GreenPower in the NT, you buy your electricity as per usual, and then calculate how many kWh of GreenPower you wish to subsidise per day and set up a separate account with a GreenPower provider. For example, you may choose 10kWh per day, which will cost you about 30c per day on top of your electricity bill. The 30c subsidises the difference in costs between generating power with renewables and with fossil fuels.

Unfortunately, there is no current GreenPower provider in the NT but there are many in other states. The 'green' electrons will not actually be consumed by you, but by someone on the grid where the GreenPower is produced. This is actually a good thing as the renewable energy you subsidise will replace coal-fuelled electricity which is more greenhouse intensive than gas which is used to generate power in Darwin.

To qualify as a GreenPower provider, companies have to follow strict government regulations to protect the customer.

Bray, T. 2006. Greenhouse friendly habits in the Top End. CoolMob, Darwin, p10.

See http://www.coolmob.org/Attach/resources/Greenhouse_Book_web.pdf

More information about GreenPower can be found at: www.greenpower.com.au

Notes:

1 http://www.solarbuzz.com/Marketbuzz2006-intro.htm
2 http://www.nt.gov.au/dpifm/Minerals_Energy/MakeTheSwitch/index.cfm?header=Renewable%20Energy%20Projects%20-%20Latest%20Statistics
3 http://www.anzses.org/Why/Myths/Map.html
4 McQuire, S. 2006. Solar surplus 10 years in a row. In Renew. Technology for a sustainable future. Issue 96, p 19 – 22.
5 Northern Territory Government 2003. Developing a Strategy for Northern Territory Greenhouse Action, p16. Note that this discussion paper said that the uptake of solar hot water was 38%, but this figure will have increased in the last few years.
6 EcoGeneration, Issue 38, Jan/Feb 2007, p42.
7 Northern Territory Government 2003 ibid.
8 http://www.greenhouse.gov.au/renewable/pv/index.html
9 http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/6E673B244F83579CCA257156007B9D31/$File/20320_2001.pdf
10 http://www.abs.gov.au/ausstats/abs@.nsf/0/812343b3e6694d5dca256d3c0001f4c9?OpenDocument
11 EcoGeneration, Issue 38, Jan/Feb 2007, p29.
12 http://www.originenergy.com.au/home/home_subnav.php?pageid=174
13 http://www.maketheswitch.nt.gov.au
14 http://www.ata.org.au/wp-content/policy/ata_coag_submission.pdf
15 http://www.solarbuzz.com/FastFactsGermany.htm
16 ibid
17 EcoGeneration, Issue 38, Jan/Feb 2007, p28.
18 Trevor Horman, Power and Water Corporation (pers. comm.)
19 http://www.deh.gov.au/minister/env/2006/mr26sept06.html
20 http://www.greenhouse.gov.au/solarcities/pubs/solarcities-update.pdf
21 http://www.abs.gov.au/ausstats/abs@.nsf/94713ad445ff1425ca25682000192af2/738488bd76f41498ca256dea00053964!OpenDocument
22 ibid
23 http://www.nt.gov.au/nreta/environment/greenhouse/issues/trends.html
24 http://www.coolmob.org
25 http://www.ata.org.au/wp-content/policy/ata_coag_submission.pdf
26 ibid
27 ibid

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