Submission to: **Inquiry into Indigenous economic development in Queensland including issues surrounding Queensland's *Wild Rivers Act 2005*.**

The House of Representatives Economics Committee

From: Dr. Barrie Pittock, PSM, (Hon Fellow CSIRO),

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*Re:* 3) options for facilitating economic development for the benefit of Indigenous people and the protection of the environmental values of undisturbed river systems.

*Submission:*

I am separately attaching a paper written by me or the CRC for Remote Economic Participation.

In brief, this paper suggests that there are large social co-benefits in constructing large renewable energy generators in remote parts of Australia as they would provide employment and income for remote communities, especially Aboriginal communities, subject to negotiation and agreement with those communities.

In the case of Queensland, and Cape York in particular, large renewable energy resources are available in the form of wind power from the trade winds and solar power, particularly in the dry season. Tidal power may also be viable in some coastal locations.

My point is that this would not only provide renewable low-emission energy to deal with the climate change problem, but local employment and income. Studies referred to in my paper indicate that renewable power installations provide local employment, not only in the development stage but in the longer-run maintenance phase. US studies indicate this can be much larger than local employment from fossil fuel power stations.

Such co-benefits make the proposal more economically attractive and might support the provision of initial subsidies for extending the electricity grid gradually into remote areas to pick up the potential solar and other renewable energy resources. My paper is well documented with relevant reports and may prove useful background on these issues.

The feasibility of my suggestion is reinforced for Queensland by the recent announcement of plans by Origin Energy to transmit hydro-electricity by a high voltage DC cable from Papua New Guinea to the Queensland grid via Cairns. See reference in my paper. Other renewable energy output on Cape York could be connected to this grid.

I would be happy to discuss this further with you. Despite my position as an Honorary Fellow in CSIRO, this submission is my private initiative, not from CSIRO (as it has policy advocacy implications in the present context).

**Invited paper: Desert Knowledge Symposium Nov.2010 (now postponed) for opening discussion**

# Energy Futures and Climate Change

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## Introduction/Summary

Desert/remote Australia is blessed with abundant natural energy resources from solar, geothermal and other renewable sources. If these were harnessed and connected appropriately desert/remote Australia could not only be energy self-sufficient but a net exporter. Abundant, clean (i.e., non-polluting) energy can also attract energy-intensive industries, thus providing local income and employment.

Regardless of renewable energy's contribution to reducing climate change, the world is already committed to global warming and associated climate changes (IPCC, 2007a, Pittock, 2009a). Desert/remote Australia will thus inevitably get warmer, lowering the comfort factor of dwellings, and may be subject to increased extremes such as flooding, longer dry spells, more severe storms and coastal inundation.

In addition, the prospect of world demand for oil from conventional sources exceeding supply will likely lead to oil shortages, higher oil prices, and additional incentives to provide alternative energy supplies. The region is heavily reliant on fossil fuel dependant motor vehicles and airplanes for transport for within-region mobility, the importation of goods, the tourism industry and emergency medical services.

Without adaptation, climate change and peak oil could be expected to make living in desert/remote Australia less attractive resulting in increased difficulty of attracting and retaining skilled workers, which would constrain development.

Several questions arise:

- How will climate change and peak oil shape economic development and social sustainability in remote/desert areas?
- What options exist to plan for the dual impact of climate change and energy crises?
- How can Aboriginal perspectives on adaptation inform the development of a desert intercultural climate change response?
- What policy settings would foster desert/remote area contributions to regional and national sustainable energy strategies?

The focus of the present paper is on the climate and energy-related impacts and potential responses. These are both a challenge and an opportunity and could provide additional employment and income, thus helping remote communities to overcome some serious social problems. The paper attempts to review current knowledge, provoke debate on relevant investment strategies, and to tease out the questions in need of further research.

It suggests an agenda for the CRC-Remote Economic Participation theme "Energy Futures and Climate Change" and for other relevant research and investment bodies.

## 1. Climate change impacts on desert/remote Australia

### *1.1 Climate change and risk*

Climate change projections necessarily depend on assumptions regarding future emissions of greenhouse gases, and have many uncertainties due to the highly complex nature of the climate system. The potential impacts regionally and globally may be very serious and may require important changes in economic and technological systems. However, the uncertainties about future climate have led some people, whose commercial and/or ideological interests appear to be threatened or who are otherwise in denial, to focus on the least possible impacts and to deny that more serious impacts are possible or even likely. Such people argue that they are merely applying normal scepticism to the conclusions of climate change scientists. This usually pits supposed "common sense arguments" for denial against relevant professional expertise, analogous to a patient with the early symptoms of a disease rejecting unwelcome advice from a medical specialist.

However, the strong consensus of climate change scientists is that the well recognised uncertainties contain a significant risk of serious impacts that ought to be taken into account in planning and policy measures. Risk is defined as the probability times the magnitude of any impact. Future climate change and its possible impacts and opportunities are matters for risk management policies (i.e., preventive measures and insurance). Even a small probability of a highly damaging outcome requires precautionary action rather than inaction on a "wait and see" basis.

It is sensible, therefore, for the public and decision-makers to take seriously the well refereed summary conclusions of thousands of scientists summarised in the various reports of the Intergovernmental Panel on Climate Change (IPCC, 2007a and b) and supported by many reports and statements from National Academies of Science and professional scientific bodies (see summary in Pew Center, 2009, and Pittock 2009 a).

In Australia, the Bureau of Meteorology, CSIRO, the Academy of Sciences and numerous university scientists and institutions have issued reports and statements (including *Climate Change in Australia*, Technical Report, CSIRO 2007; *State of the Climate*, joint statement by CSIRO and the Bureau of Meteorology (BoM), 2010; and *Risks from Climate Change to Indigenous Communities in the Tropical North of Australia*, Green et al., eds., 2009). See also Pittock (2003). The present paper takes these reports into account in making the following summary statements regarding climate changes and impacts likely in desert and other remote regions of Australia.

### *1.2 Observed and projected climate changes:*

The CSIRO-BoM joint statement documents a warming trend over the whole of Australia from 1960 to 2009 of up to 0.6ºC per decade in parts of inland Australia, with lesser

warmings in many coastal areas including the Kimberley region in the NW where rainfall has increased. Despite year-to-year variability, rainfall trends have been small in central Australia, but there have been decreases in southern and eastern regions.

Globally, average sea level has risen by some 20 cm from 1870 to 2007. Locally, from 1993 to 2009 sea level has risen by 1.5 to 3 mm per year in the southern and eastern coastal regions, and by 7 to 10 mm per year in the northern and western coastal regions. Regional differences are largely due to variations in ocean currents.

The global atmospheric carbon dioxide ($CO_2$) concentration in 2009 was 386 parts per million, which is much higher than the natural range of 170 to 300 parts per million that existed for at least the last 800,000 years. Besides driving global warming, this increase is causing increases in acidity of the oceans, as has already been observed.

The joint statement concludes that Australia will become hotter in coming decades, with especially more hot days, and that much of southern and eastern Australia will become drier. The statement also restates the IPCC (2007a) conclusion that there is greater than 90% certainty that increases in greenhouse gases have caused most of the observed global warming since the mid-19$^{th}$ century, and that it is extremely unlikely that the global warming could be explained by natural causes such as variations in solar output (Pittock, 2009 b).

More detail of projected climate changes in regional Australia can be found in a paper by Suppiah et al. (2007) and in Chapter 11 of the IPCC (2007b) WGII report. These suggest that in central Australia warmings are likely to be in the range of 0.5 to 4.0ºC by 2050 and 0.8 to 8.0ºC by 2080. The wide range is partly the uncertainty from different climate models and partly from uncertainty as to future levels of greenhouse gases. Without marked reductions in the rate of increase in greenhouse gas emissions, future warmings are likely to be in the upper half of the stated range. Warmings are projected to be less near the coast.

The Australian reports are not conclusive about projections of rainfall changes in northern Australia, with climate models predicting a wide range of possible changes centred around no change, despite observed increases (CSIRO, 2007b; Suppiah et al., 2007). Nevertheless, the risk study by Green et al. (2009) does suggest an increase in wet season rainfall in most of tropical Australia (p.30).

Moreover, simple first-principles suggest that monsoon circulations are primarily driven by land-sea temperature differences between continents and their surrounding oceans, with greater warming over land leading to increased updrafts which would increase the release of latent heat of condensation, driving more intense convection. This suggests that the Australian monsoon should be intensifying with global warming, as ocean temperatures would tend to lag behind continental temperatures. This is complicated by the effects of atmospheric pollution of the lower atmosphere (particulate pollution from human activity), which to the north of Australia might be expected to arise largely from industrial pollution in SE Asia, thus having a regional cooling effect on the waters north

of Australia. This suggests a further strengthening of the Australian monsoon, but this remains controversial. Increased smoke cover over northern Australia due to increased bushfires could work against a stronger monsoon, but this effect might be expected to decrease once the monsoon has set in, doused the fires and washed out the smoke.

The Australian reports do not highlight increases in rainfall intensity, but the IPCC (2007a) report projects increased rainfall intensity in general, even in some areas where average rainfall decreases. This is essentially due to the capacity of warmer air to hold more moisture, so that more intense convective rainfall is likely. This also applies to tropical cyclones (TCs), with an expectation of a greater number of intense TCs, even though the total number of TCs may not increase.

*1.3 Projected impacts:*

Projected impacts are discussed in some detail in the report by Green et al. (2009), but this is confined to Indigenous communities in the tropical North of Australia, and thus does not consider many of the more inland desert region communities. Chapter 11 of the IPCC Working Group II report (IPCC, 2007b) covers impacts in Australia and New Zealand in general, but with little detail on many remote areas.

The most obvious projected impacts are marked increases in the number of extremely hot days in inland Australia, and decreases in the frequency of extremely cold days. This will seriously impact on comfort levels in buildings and especially increase the need for cooling in the warm season, and thus on energy and water demand for cooling systems. It may also contribute to greater wildfire risk, especially in the dry season and where rainfall does not increase, although fire spread and intensity will depend on the density of vegetation, which may change with the climate. Impacts on animals and humans outdoors will also be significant.

Increases in tropical cyclone severity will have serious impacts on coastal communities, due to stronger winds and also larger storm surges on top of long-term sea-level rise. Communities further inland will also be affected by strong winds and extreme rainfall events associated with tropical depressions resulting from cyclones moving inland. This is likely to increase the severity of riverine flooding.

The Green et al. (2009) report considers the effects on Indigenous communities in the tropical north, especially on biodiversity, health, infrastructure, education and livelihood opportunities. It is worth quoting the resulting summary of impacts of global warming and possible strategies for coping with it, as these apply generally to remote Indigenous communities:

- *Climate projections for the region indicate a range of biophysical impacts with various levels of certainty. Uncertainty in climate projections will be an ever present constraint; however this concern cannot be allowed to delay action. There is sufficient certainty to enable immediate policy development, as well as to*

*further research agendas and engage with the community directly about prioritising activities (discussed in Chapter 2).*

- *Climate change will impact the natural environment of the north both directly and indirectly, with major flow-on implications for remote communities dependent on natural resources. These impacts are generally poorly understood although it is clear that the role of people in the landscape to manage these impacts will be crucial (discussed in Chapter 3).*

- *Climate change is likely to exacerbate existing, and create new, health risks for Indigenous people. Proactive adaptation to these risks would lead to no-regrets improvements to health. These strategies should be identified and acted on as soon as possible (discussed in Chapter 4).*
- *Both transport and communications infrastructure in many areas of the study region are extremely limited. Climate change will cause disruption to the infrastructure that does exist, particularly in coastal regions. Improving key access points, raising new and existing building standards for cyclone-proofing and enhancing the resilience of local energy provision and maintenance systems are critical investments (discussed in Chapter 5).*
- *Education has an important to role to play in preparing northern communities for climate change. However, amendments to current curricula are required to enhance the capacity of communities to adapt and build resilience to climate change impacts. The role of Indigenous knowledge in strengthening cultural resilience must also be specifically recognised in any education program (discussed in Chapter 6).*
- *Some economic opportunities may arise from the need to better manage, and in some cases restore, ecosystems for biodiversity conservation and for carbon dioxide mitigation and sequestration activities. Opportunities and livelihood options related to this issue need to be better understood (discussed in Chapter 7).*

While the Green et al (2009) report is focussed on Indigenous communities its conclusions are in general applicable to non-Indigenous communities as well, and must be seen as essential considerations in town planning and development.

## 2. 'Peak Oil' and energy prospects in the 21st century

The idea that oil production would reach a peak and then decline was first put forward by M King Hubbert in 1956 (see Deffeyes, 2001). He predicted that U.S. oil production would peak in the early 1970s, which it did. Repeated oil shortages in recent decades have caused rapid, although rather spasmodic, rises in oil prices, and it is now clearly evident that oil extraction is becoming more difficult. Shallow oil deposits are becoming depleted and deeper oil wells, especially offshore, are now necessary. These deep oil wells are more costly and open to damaging spills such as that in the Gulf of Mexico in 2010. Resort is also being made to exploitation of shale oil and tar sands, both of which present environmental problems and are more expensive as they require large amounts of energy to extract the oil.

The situation internationally was put into stark relief by the US ambassador to Australia recently (Bleich, 2010) who wrote *"… fossil fuels are indisputably finite – unlike wind, solar, biofuels and other renewable sources. They will run out one day, and our economies will collapse with them unless there is an alternative. In short, our reliance on fossil fuels threatens not just our environment, but our economy, our national security, and every aspect of our future*." (Melbourne Age, 12 June 2010).

The temporary halt to oil price rises during the global economic crisis of the late 1990s may well resume as soon as there is an economic recovery that lifts demand (see e.g., ASPOG, 2010; Global Energy Systems, 2010; and references in Pittock, 2009 a, pp.208-9). This will have severe economic repercussions, especially for sectors dependent on oil in the form of petrol or diesel. This includes most of the remote areas of Australia where transport, machinery operation and even electricity generation is highly dependent on these commodities.

There will be serious impacts on day-to-day living in remote Australia, and an urgent need for alternative sources of electricity and fuel. Railways will need to be electrified and cars, trucks and machinery run on biodiesel or other alternative fuels such as electricity or hydrogen fuel cells. Even such alternatives as liquid ammonia, used during World War II, may be needed, and may indeed prove to be economic (AFN, 2010; NH3, 2010; Bruce et al., 2008). Ammonia can be generated from hydrogen and nitrogen, with the hydrogen itself coming from the hydrolysis of water by electricity from renewable sources, reacting with atmospheric nitrogen. Biodiesel is the most popular suggested alternative to oil, but it requires water to grow biomass and energy to harvest and collect the biomass. Even air transport, vital to many in the outback, especially in emergencies, may need to run on alternative fuel.

**3. Possible responses to climate change and peak oil**

a) *Avoid damaging climate change through reduction of emissions*. This is a global requirement and Australia must play its part, both locally and via international agreements, motivated by likely local, regional and global impacts of global warming. The local response must include reduced reliance on fossil fuels and thus more reliance on renewable energy. This need will be accentuated by the onset of 'peak oil', or at least by rising oil prices when demand picks up after the global financial crisis.

This suggests that biofuels or other alternatives for transport will be in demand, e.g., stored electricity in car batteries, hydrogen fuel cells or liquid fuel alternatives such as biodiesel or ammonia as discussed above. Water availability may become a key issue, both for biofuel generation and for domestic and industrial cooling.

b) *Proactively manage impacts,* This includes planning for and investing in measures to cope with rising sea levels, greater warmth, more extreme flooding and wind *storms, and possible health impacts.* This will require massive efforts to modify and strengthen infrastructure to withstand extreme climatic conditions, especially heat, damaging winds,

and coastal and riverine floods. Appropriate zoning and design rules will be needed. As is widely accepted elsewhere (e.g., see IPCC, 2007b, chapter 20 'Perspectives on climate change and sustainability'), an essential element in better coping with the impacts of climate change is sustainable development, which increases society's ability to cope with stresses, damage and disasters. This is crucial in the case of lesser developed communities or countries, which can ill afford to cope with adverse climatic events. Lessons learnt in the Desert Knowledge CRC Core Project 4 (Sustainable Desert Settlements) are relevant here.

c) *Seize opportunities. These include especially greater demand for renewable energy, including stationary electricity and transport fuels.* Such opportunities will become increasingly attractive as the costs of fossil fuel energy increase, and renewable energy technology becomes cheaper. As renewable energy opportunities are abundant in remote Australia (Seligman, 2009; Beyond Zero Emissions, 2009; Climate Institute, 2010; Climate Works Australia, 2010; Dept. of Resources, Energy and Tourism, 2010), this provides a great opportunity for increased local employment and income (ACF and ACTU, 2008 and 2010; Hatfield-Dodds, et al., 2008).

Linking remote Australian communities to the national electricity grid may provide other opportunities also, not only in installing and maintaining the grid but eventually in possible export of energy and fuels to Asia via links to Indonesia (Desertec-Australia, 2010). Desertec-Australia's claims in this regard may seem extravagant, but the analogous European Desertec Foundation proposals for supplying Europe from renewable energy in North Africa and the Middle East are beginning to be acted upon (see www.desertec.org) despite political instability in the region.

A study by PriceWaterhouseCoopers (2010) supports the idea of a Europe-North Africa power market with a unified intra- and inter-continental grid, while an International Energy Agency study identifies large renewable energy potential within Southeast Asia (Ölz and Beerepoort, 2010). See also *Energy Technology Perspectives 2010* (IEA, 2010).What is economically possible in regard to export of Australian renewable energy to Southeast Asia remains to be thoroughly explored.

d) *Anticipate, plan and invest in other potential shifts in employment and income sources.* These will include changing farming and forestry practices and opportunities as climate changes. Aspects of "caring for country", such as in conservation of biodiversity and carbon sequestration, will be increasingly important. Production of biofuels from vegetation such as at Verve Energy's Integrated Wood Processing (IWP) plant (which uses Mallee scrub) is already being explored (Verve Energy, 2006).

e) *Wait, see and cope with any changes.* For those who remain sceptical about the prospect of serious climate change impacts this may appear to be the best option. It necessarily includes a willingness to cope with and rebuild after any damaging impacts, or to retreat (i.e., migrate from untenable areas). It may be very costly and may quickly become an unacceptable option.

**4. Renewable energy opportunities in remote Australia.**

Australia is blessed with the most solar energy of any country in the world, plus geothermal, wind, tidal etc., especially in remote areas. This is well documented in several reviews including that of Seligman (2009), Beyond Zero Emissions (2009), Climate Institute (2010) and Dept. of Resources, Energy and Tourism (2010).

[Insert maps of global solar energy and Australian geothermal prospect]

Solar energy is clearly most abundant in inland and desert Australia but also seasonally in more southern regions in summer and in more northern monsoonal regions in winter. Seasonal and east-west time zone differences of up to three hours mean that a national electrical grid can largely smooth out seasonal and daily demand cycles to provide effective baseload power. Solar thermal storage, pumped hydro (either from existing dams or from coastal cliff-top storages using seawater as discussed by Seligman, 2009), use of car batteries or generation of hydrogen or other fuels can all add to the ability to satisfy demand in a timely fashion.

The need for reduced greenhouse gas emissions provides a strong in-principle incentive for more renewables. This would be assisted economically by a price on carbon emissions, either through a carbon trading scheme or a direct tax, but can also be stimulated by possible start-up or other incentives. Renewable energy targets are one such mechanism, but it may well be that providing a suitably extended electrical grid and/or energy storage systems might encourage economies of scale that make renewables economically competitive within a decade or two. There is a clear need to model the economics of such schemes taking account of all the costs and benefits including local employment, environmental and health benefits. Fossil fuel energy also has costs not usually considered, such as other environmental pollution, health hazards and numerous subsidies, tax concessions and infrastructure costs.

There is already wide interest in renewable energy developments, not only from environmental NGOs but from business and government authorities. However, most bodies have failed to recognise the co-benefits to remote area communities, which if quantified could add to the economic case for such developments.

The Australian Energy Market Operator (AEMO) has studied the economics and design details of an extended electricity grid (AEMO, 2009a) and in particular done a case study of an extension to Innamincka (AEMO, 2009b) near the Cooper Basin geothermal development. These studies discuss the relative merits of high voltage AC versus DC transmission, and conclude that a mixture may be most appropriate, with DC most economical for long uninterrupted transmission lines or where easements may be constricted, or underground or undersea cabling is needed.

The AEMO (2009b) study estimates the cost of extending the grid to include the Cooper Basin at around AU$2-5 billion depending on the routes and capacity. Clearly the costs of easements would be reduced if they could be combined with easements for other

purposes such as the trunk lines for the National Broadband Network (NBN), which has a total price tag of some AU$43 billion. The question arises as to which would be of greater national importance, a national electricity grid or a national broadband grid (especially as wireless technology is possible for computer broadband transmission), or whether some combination of the two is most appropriate.

To put these cost estimates in perspective, according to Paddy Manning in the Melbourne *Age* of 12 June 2010, "forecast spending on Australia's electricity network over the next five years is the country's biggest single-ticket infrastructure item, at an estimated $47 billion." This includes high voltage transmission lines, spending on the distribution network and maintenance, but apparently nothing to cut greenhouse gas emissions.

The NGO 'Beyond Zero Emissions' has produced a report *Zero Carbon 2020* which describes and costs a proposal to enable Australia to change to 100% renewable energy by 2020, using only "proven and commercialised technologies". This effectively confines the scheme to using wind and solar power with storage, including pumped hydro power, and some biomass, but not geothermal, other biofuels, nor tidal or wave power. It does not include grid extensions into remote Australia, apart from a link from Port Augusta to the WA grid. It envisages all-electric public and private transport from renewable sources. This proposal estimates net additional investment costs for the stationary energy transition at some AU$200 billion over ten years, in the absence of future carbon prices or escalating oil prices, which they claim would make the scheme economically favourable.

Meanwhile, Origin Energy has already signed up to a joint venture, with a memorandum of understanding with the governments of Papua New Guinea and Queensland, for a large hydropower project in PNG that would export energy via a HVDC power line routed through Weipa on Cape York to join the national grid at Townsville. This would enable renewable energy generators on Cape York to be connected also (Origin Energy, 2010).

The potential for geothermal energy worldwide is huge (Grimsson, 2007), as it is in Australia (Chopra and Holgate, 2005). It is already well on the way to development in Australia with companies such as Geodynamics Ltd. (see www.geodynamics.com.au), Torrens Energy (see www.torrensenergy.com) and Petratherm (see www.petratherm.com.au) working on preliminary drilling and site testing. Geodynamics is exploring geothermal resources in sites in the Cooper Basin near Innamincka, while Torrens Energy and Petratherm have sites in or near the Flinders Ranges. They are also exploring other sites in less remote areas.

Tidal energy also has large potential in coastal areas of northern and western Australia where tidal ranges are large. The Blue Mud Bay decision (High Court, 2008) recognizing traditional owners' property rights in tidal waters gives Indigenous people a large economic stake in any tidal power developments.

*Employment and income potential from renewable energy*

The crucial issue regarding the development of renewable energy resources in remote Australia from the social benefits viewpoint is: What employment and income benefits would such development provide, and can that be accounted for in terms of a national economic benefit?

A sizeable literature exists on the potential economic opportunities created by renewable energy developments (e.g., European Commission, 1997; Apollo Alliance, 2008, 2009; ACF and ACTU, 2008; Center for American Progress, 2008; Hatfield-Dodds et al., 2008; Khosla, 2008; Mills and Morgan, 2008; UNEP, 2008). Some of these reports claim that millions of jobs can be created from the large-scale deployment of energy efficiency and renewable energy in Europe, the United States and elsewhere, although much of that employment would be in the manufacture and export of equipment such as solar cells.

One of the most applicable reports to the present proposal is a Californian study by Stoddard, Abiecunas and O'Connell, 2006. This study compared employment created by the development of concentrated solar power technology as compared with combined cycle or single cycle natural gas plants. They found that for each 100 MW of generating capacity, concentrated solar power would result in 94 permanent operations and maintenance jobs, compared to 56 for combined cycle and 13 for simple cycle gas turbine plants. At least two other reports give similar estimates: CSP Today (2008) estimates 100 ongoing jobs per 100 MW, while Greenpeace/ESTIA/IEA (2005) suggest 120 permanent jobs in maintenance and operations per 100 MWe unit.

The ACF and ACTU (2010) study, based on modeling by the National Institute of Economic and Industry Research, estimates that under a "deep cuts in emissions" scenario, some 3.7 million jobs would be created across the whole Australian economy by 2030 (compared to 3.0 million under a weak action scenario). How many of these jobs would be in remote Australia would of course depend on whether remote renewable energy resources are in fact developed. Hopefully the present proposal would ensure that an appreciable proportion of new jobs would be in remote areas.

While such estimates depend on the detailed assumptions, they suggest that sizeable direct employment opportunities could be created by renewable energy development. There would also be secondary employment opportunities using locally produced heat or power, for example to fire pottery kilns as part of an Indigenous art industry (Peter Lain, personal communication), production of liquid fuel for transport, or even pumping and desalinization of water for industrial or agricultural purposes.

There is however, some scepticism regarding the number of local on-site jobs that might be created as opposed to fly-in experts (Mark Diesendorf, University of NSW, personal communication). This needs further investigation, but any agreement with developers should be conditional on at least some local employment, with on-the-job-training.

Given that local employment opportunities would be created by large-scale renewable energy development, a central question is how this might be financed. Collaboration will

be required between Indigenous bodies, private companies and governments to realise such opportunities.

**5. Social co-benefits for Indigenous and other remote communities**

One of the most important economic and social co-benefits of a large renewable energy industry in remote areas of Australia, especially in or near remote Indigenous communities, is the provision of income and employment for local people where they are, rather than potential workers having to move to distant places. While economic disadvantage is only one aspect of Indigenous disadvantage (Hunter, 2008), where economic development programs are culturally appropriate and supported in the long term they potentially help build resilient economic systems and communities less dependent on government-funded social welfare.

Many remote Indigenous communities (which in most cases are growing in population), and town camps on the edge of larger non-Indigenous communities, have suffered from social problems such as alcoholism and other substance abuse, violence and social discord. This has sometimes been attributed to their Indigenous cultural heritage. This may be partly the case with some cultural elements inconsistent, at least in part, with modern economic society (Sutton, 2009; Pearson, 2009). Voluntary evolution of culture to include practices appropriate to modern society and its economic practices may well be necessary. However, lack of economic opportunity or resources is also a key underlying causal factor in many communities.

. Some people who do not value Aboriginal cultural identity argue that abandonment of remote “unviable” Aboriginal communities will separate Aborigines from their allegedly unsustainable and dysfunctional traditions and practices and force them into the mainstream and supposedly more sustainable society (Bennelong Society, 2006; Hughes, 2007). However, continuing problems in larger regional centres suggest that this is not the case. Indeed, in many of these regional centres meaningful employment and income is not available and welfare dependency is becoming more common. This is sometimes referred to as “welfare colonialism” and has been the subject of much scholarly and public debate (Sutton, 2009; Pearson, 2009, and comments by Nicholls, Sarra et al., 2009). Recently this debate has centred on the Howard Government’s “intervention” in the Northern Territory and the role of welfare payments and availability of alcohol.

The widespread occurrence of similar social problems in other low-resource low-income communities in other countries, irrespective of cultural background, suggests that in Indigenous Australia dysfunctional social problems are at least partly the result of social disadvantage (including social and economic disempowerment), rather than peculiarly Indigenous cultural traditions. Indeed the American sociologist Oscar Lewis reached a similar conclusion from a study of similar problems amongst poor communities of Mexicans, Afro-Americans and Puerto Ricans in the United States as long ago as the 1960s (Lewis, 1967; Pittock, 1977). Lewis’ dignified this poverty syndrome as a “culture of poverty”. Lewis’ terminology and categorisation has been contentious (Coward et al., 1973; Gajdosikiene, 2004). However, his observation that unemployment in such

communities often led to lack of self-respect, substance abuse and family violence, with women often having to assume the role of breadwinner or matriarch, remains true in many poverty situations. This is moderated in many remote "homeland" Aboriginal communities by the traditional roles of Aboriginal men and women as keepers of cultural tradition, but these roles are often broken down in fringe-dwelling communities distant from the Aboriginal home country.

While proper bi-cultural education is important (Pearson, 2009), and prohibition of alcohol may treat one important problem (Sutton, 2009), lack of economic resources is an underlying factor in many Indigenous communities. The case for recognition of Indigenous land rights was indeed fought both to preserve Indigenous relationships with the land for cultural reasons and to provide an economic base (Pittock, 1972). As I wrote in 1971 "*The continuing historical process of dispossession has deprived the Aboriginal people, and their part-Aboriginal descendents, of both their cultural heritage and their economic independence. This is at the root of the present situation of Aboriginal poverty and alienation. The Aboriginal and part-Aboriginal people cannot be successfully integrated into an affluent twentieth century society unless they have some economic capital and bargaining power, and indeed a stake in the emerging multi-racial Australian community.*"

Most remaining un-alienated Indigenous land holdings were left alone following European settlement essentially only because they lacked substantial economic value to Europeans at the time. Any economic value was in traditional hunting and gathering, and possibly in running cattle. More recently some have gained economic value as tourist destinations or as the base for evolving Aboriginal arts and craft enterprises. It is only now that their value as sites for much needed renewable energy enterprises is becoming apparent.

This analysis highlights the importance of utilizing opportunities to provide meaningful employment and income in regional and remote communities in order to break down the material poverty which is crippling Indigenous society. These communities need to become economically viable, thus enabling Aborigines to rebuild functional societies and at the same time to retain close links with traditional country. This has already happened in some Aboriginal and Islander communities, especially through the development of tourism and arts and crafts industries, including of course activities and expressions which are not strictly traditional. These include now-recognised regionally specific modern traditions in painting, fabric and pottery. Based on US examples, I advocated such activities over four decades ago (Pittock, 1967). Evolution in traditional Aboriginal cultures have now incorporated foreign techniques such as batik, pottery and other practices into so-called traditional arts, just as Southwest Indians in the US incorporated silver work, looms and even skiing into their arts, crafts and tourism industries.

The rich resources of renewable energy that are contained in many remote areas of Australia, clearly provide modern Indigenous communities with opportunities for earning income, thus providing employment and long-term viability of their communities. In view of the large economic and technological investments necessary, clearly such

developments will need to occur with the joint participation of Indigenous communities and outside commercial interests.

Clearly, existing or proposed remote non-Indigenous enterprises should be encouraged or required to provide training or apprenticeships to local Indigenous people to be employed preferentially as staff in manual or preferably skilled jobs of maintenance and construction. This is already implicit in the *Australian Employment Covenant* (see www.fiftythousandjobs.com.au), which is a private sector initiative supported by the federal government, but this does not specifically encourage local employment and to date has fallen well short of its target. However such employment opportunities need to be supported with culturally appropriate employment practices.

Offering job opportunities in developments far removed from traditional communities would either not be taken up in large numbers by Indigenous people or would have the adverse effect of removing young potential leaders from their home communities and setting them down outside the restraints and comforts of family and traditional communities and the tutelage and oversight of their elders.

In contrast to mining and tourism, which are both location-specific industries that in many instances cannot readily be co-located with existing remote settlements, renewable energy resources are extremely widespread in remote areas of Australia. In particular, desert Australia, almost by definition, has large amounts of solar energy, but also widespread geothermal energy. In less arid and more coastal areas opportunities also exist for wind farms, biofuel production and tidal power. Development of these renewable resources can in many cases be co-located with existing remote settlements, whether Aboriginal, Torres Strait Islander or non-Indigenous.

Another example of a climate-related opportunity is the West Arnhem Land Fire Abatement Project (WALFA) which uses skilled Indigenous fire managers in fire prone savanna country to reduce greenhouse gas emissions, protect culture and biodiversity and bring socio-economic benefits to their communities via employment and carbon sequestration credits (Tropical Savannas CRC, 2010).

Renewable energy development on a large scale would thus provide a huge opportunity to simultaneously solve the two central problems of reducing carbon emissions and solving social problems related to lack of employment by developing a diverse local economy based on people, skills and energy resources.

**6. Research questions arising:**

*Adaptation needs and solutions*

The broad issues here are well spelt out in the IPCC (2007b) report and in the Green et al. (2009) report quoted above. These will need to be tackled individually for many communities depending on their location and vulnerability to coastal or riverine flooding, present and future climatic conditions, and existing infrastructure, including housing,

roads, communication links etc. A lot will depend on the provision of local and outside resources to tackle often expensive adaptation measures such as building levee banks, relocation to higher ground, or strengthened or otherwise modified buildings and other infrastructure. Water supply and medical facilities will also need upgrading. Measures arising from new developments such as large-scale renewable energy production could well change the nature of many communities.

*Economics of large-scale renewable energy with grid extensions.*

This has been examined in parts by such bodies as the Australian Energy Market Operator (AEMO, 2009 a and b) and Beyond Zero Emissions (2009), and in order of magnitude estimates by Seligman (2009). However none have yet calculated the economics of schemes specifically designed to capture the advantages of a national grid with 3 hr. time zone differences and zonal differences that can offset seasonal variations between monsoon and other regions, and with disparate sources including solar, wind, tidal, hydro and geothermal with various energy storage systems.

This might well include phased developments radiating out from the existing grid to the margins e.g., into Cooper Basin, Port Augusta, and then on to be truly national with links to WA, Alice Springs and Darwin. Such calculations should also explore economies from co-development with the National Broadband Network, sharing infrastructure such as easements, transmission towers and cabling as far as that is possible.

In its 2007 Annual Report the major engineering company Worley Parsons revealed a plan to build 34 advanced solar thermal power stations by 2020, each 250 MW peak output, to supply 50% of the proposed Australian renewable energy target of 20% of all Australian electricity by 2020. It planned to do this in collaboration with some of the leading companies operating in Australia, including Rio Tinto, BHP Billiton, Woodside and Wesfarmers. Perhaps due to the global economic crisis and the failure of the federal government to go ahead with its emissions trading scheme, this proposal seems to be onhold, but Worley Parsons as of late 2009 was working on a solar flagship proposal for Port Augusta “that we can extend to a solar gas hybrid power station and then to solar geothermal in the Cooper Basin” (Peter Meurs in ATSE, 2009).

Geoff Wearne of Worley Parsons commented (personal communication, June 2010) “The key driver for WorleyParsons is to have a solar facility constructed to prove that it works. The problem at the moment is the cost of electricity generated via solar vs that from fossil fuels. Unless there is a high price on carbon, Origin Energy and others will continue to build gas facilities that will ensure that solar is not economic.”

In the present financial climate such large-scale solar energy developments seem to depend in part on government incentives. While some small grants have been made to some projects, more systematic incentives such as a price on carbon emissions or subsidized electrical grid connections for remote sites are lacking. Perhaps a national grid is an essential prerequisite for business investment in such developments.

Alternative solar technologies (see e.g., Wagg, 2010) are also an issue and need further investigation. See for example the discussion in CSP Today (2010) where Dennis Orwig of Novatec Biosol argues that Fresnel technology is preferable to solar troughs as it is more efficient, requires less infrastructure and cost to build and uses less water. Water use and supply is indeed a key issue in remote Australia, so water needed for cooling or cleaning solar (and geothermal) plants is critical. This will depend on the particular technology employed and solar power could be used to desalinate bore- or sea-water where needed. Part of the European Desertec Foundation proposals is to use solar power for large-scale desalinization in North Africa.

Clearly, key questions regarding the economics of large-scale renewables are (a) the technology, which is rapidly developing and becoming more economic, and (b) the economic incentive framework such as a price on carbon emissions and the development of a national electrical grid which new electricity developments can plug into at little extra cost.

*Job opportunities in construction of and ongoing renewable energy projects, and skill levels needed.*

A key question is how many jobs would be created both in manufacturing and in maintenance, in urban centres and remote areas, and the level of skills required. The related key question is how many of these jobs would or could be filled by local people in remote areas and how many from people brought in from elsewhere on a temporary basis, as is the case now with many mining developments. Regional social benefits would depend in large measure on arrangements for giving preference to locals and their on-the-job training, so the acceptability of this to businesses and to local communities needs to be explored.

In the case of Indigenous communities the acceptability or desirability of such developments amongst local communities is a key question, both in terms of job opportunities and of having major infrastructure developments on their traditional land. The acceptability and impact of sizeable numbers of workers coming in from outside, possibly living in camps or bringing their families, would need to be explored. And of course local communities would need to have the final say on exact location in relation to existing facilities and sacred sites.

An economic assessment of the social benefits in financial terms, such as avoided costs of unemployment benefits, subsidized housing and health provisions, and of other measures to cope with the symptoms of poverty seems desirable. Given that tens of thousands of Australians living in remote areas are involved, such sums could be considerable and could be a powerful argument for such developments. Indeed, a preliminary study by Access Economics for the Desert Knowledge CRC in 2009 estimated a possible benefit of closing the economic gap between Indigenous and non-Indigenous Australians by 2029 of about AU$2.9 billion per annum (Access Economics, 2009). Clearly increased employment and income from large-scale renewable energy would contribute a large proportion of this amount, but this needs further study.

*How to relate large-scale renewable energy development to Indigenous communities*

Involvement of and support from Indigenous communities is essential for any successful development. This will only happen if key organizations such as the Central and Northern Land Councils (CLC and NLC), the North Australian Indigenous Land and Sea Management Alliance (NAILSMA), the Centre for Appropriate Technology (CAT) including Bushlight, and others want to be involved. Such bodies already have many successful projects under their belts, considerable relevant skills, and could mobilise people and resources.

This should not be a top-down process. Local communities should be involved in the planning and in the encouragement of the acquisition of relevant skills at the local level through appropriate schooling and scholarships. As in the case of Indigenous involvement in the tourist industry, each community will be a different case, with different organizations, resources, skills and interests. As one training organisation has recently put it "it is time to stop the process of doing 'it' to people or for people and to start doing 'it' with people." (see http://www.improvingservicedelivery.com/).

*Off-grid possibilities*

Given that many renewable energy resources are in remote places and in some cases it may not be economic, at least initially, to link these into the national grid, it may well be desirable to develop some of these resources off-grid. This could be to provide local power for mining and refining activities, powering railways from mines to remote ports, or for other local energy-consuming activities. These might include potteries (as at Hermannsberg) or generation of vehicular fuels such as charging batteries, electrolysis to generate hydrogen for hydrogen fuel cells, or desalinization of sea water or saline bore water for local use or even irrigated high-value agriculture, e.g., for biofuels. Generation of liquid ammonia as a vehicular fuel from hydrogen and atmospheric nitrogen is another possibility worth examination (NH3, 2010; AFN, 2010).

These possibilities all need careful technological and economic evaluation.

*Development of overseas markets?*

As discussed in section 3 above, there is a real prospect of large-scale renewable energy from North Africa and the Middle East being used to power Europe via high voltage direct current (HVDC) cables (TREC, 2007). Desertec-Australia and others have suggested similar development in Australia aimed at exporting electricity, or even hydrogen gas generated by electrolysis of water, to Asia via the Indonesian grid or pipelines (Desertec-Australia, 2010).

To some this seems a grandiose pie-in-the-sky idea. Counter arguments are that Indonesia has many renewable energy prospects of its own, and that any linking cable would be too

expensive. However, it needs careful evaluation, not as an immediate prospect, but as a possible future, perhaps decades down the track. If this is the case, the possibility needs to be taken into account in the overall design of a growing renewable energy development, with one end of any national grid conveniently located for a future link to Indonesia. If natural gas can be exported in large quantities to Asia, why not renewable energy?

A case in point is the recent government-supported proposal by Origin Energy (2010) to export hydropower from Papua New Guinea to Queensland via a HVDC cable. This not only demonstrates the possibility of inter-country electricity export, but could enable remote electricity generation in Cape York to be connected to the grid.

**6. Strategy**

Firstly, more thorough research is needed into the questions raised here. The CRC for Remote Economic Participation already has something like this as one of its themes. It thus seems like a good candidate to coordinate and/or carry out much of the needed research.

Secondly, there is already much industry interest in renewable energy developments so it is essential to bring this together to plan a coordinated program, especially in relation to the provision of a truly national electrical grid that can adapt to serve existing and new entrants into the field. As suggested earlier, this is in my view at least as important to Australia as the National Broadband Network. If this is so, it should be asserted widely.

Thirdly, such a coordinated plan must be a community driven project not a research or organisation driven project. I would suggest that Aboriginal Land Councils, the North Australia Indigenous Land and Sea Management Alliance (NAILSMA), Bushlight (or the parent Centre for Appropriate Technology), and individual spokespeople should be consulted and brought in as desired. CSIRO's Indigenous Engagement program as well as the old Desert Knowledge CRC's network would of course be consulted also.

The scale and rate of development is a key issue. I imagine that this idea will develop and come to fruition gradually, with the first links being to existing renewable energy developments such as those in the Cooper Basin, but taking account in the design of grid capacity and routing of possible future extensions such as to Alice Springs and beyond. Stand-alone remote developments should not be rejected, but at least designed with possible future external links in mind. And the possibility of developing transport fuels somehow from renewable sources should be considered and encouraged, especially in view of peak oil and a possible future oil crisis. Independence from imported oil may well become a matter of national security.

Funding is of course essential. This would take care of itself if renewables become clearly economic, as they will as the technology develops. However, this would occur much sooner if a price was put on carbon emissions according to the polluter-pays principle. In the meanwhile various government incentives seem to be essential, such as

an increased renewable energy target, start-up subsidies, and a subsidised development of a truly national electricity grid.

Various bodies already exist to foster Indigenous economic development, including the Indigenous Land Corporation (see www.ilc.gov.au), Indigenous Business Australia (see www.iba.gov.au) and the Centre for Aboriginal Economic Policy Research (see e.g., Altman and Dillon, 2004 and Altman et al., 2007). With prompting from Indigenous organisations, these bodies may well assist, but express government funding of infrastructure, or other subsidies and incentives, may be the key to corporate business investment.

I am optimistic in that I believe that China and India, as well as Europe, are already taking a lead in developing renewable energy and that this will make it cheaper and more acceptable here. This may also happen in the United States, especially following the recent major oil disaster in the Gulf of Mexico. We will not be alone in developing large-scale renewables, but if we are not diligent we may well be last of the developed countries to do so despite having the world's best renewable resources.

So finally, how do we get the momentum going? Do we need the energy equivalent of the Wentworth Group of Concerned Scientists (who confine themselves to water issues), or can we in fact go one better and include concerned business people, entrepreneurs and community leaders?

It is up to you.

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