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Green Jobs in Australia: A Status Report

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Abstract: This paper captures the breadth of complexity in the debate about ‘green jobs’ as the world seeks to transition to a ‘low carbon economy’ and to reduce greenhouse gas emissions through the reduction of reliance for energy on the burning of fossil fuels. A consideration is provided within both the Australian and international contexts of the current assertions and projections regarding green jobs, their definition and location in the economy. The substantive focus of the paper is on the development of these notions in the Australian context. We consider the understanding brought to the term and explore some of the intersections for vocational employment and training which have emerged in debate about the ways in which nations will manage the carbon pollution reduction imperative. We explore the ways forward for a coherent understanding of the need to build capacity for green jobs.

Keywords: green jobs; energy efficiency; renewable energy; climate change; low carbon economy; clean energy

1. The Intense Interest in Green Jobs

There has been a steady growth in discussion of green jobs. Economic stimulus packages, announced in response to the 2008 economic crisis, such as that in the United States [1], and recognition of the need to engage with climate change [2] have highlighted the role of green jobs. Much of the recent discussion has focused on the potential to create green jobs. However, while there is a lot of talk, to date, little data has been assembled to support the enthusiasm. This raises issues of what data are available to support

forecasts, and particularly identifies the difficulties in defining a 'green job'. In this paper we provide an overview of these issues to stimulate discussion to help our understanding of green jobs, and how we can be training people for these roles.

A comprehensive overview of global green job trends and future demand is contained in 'Green Jobs: Towards Decent Work in a Sustainable Low-Carbon World', a report from a coalition of four highly respected organisations: UNEP, International Labour Organization, International Organisation of Employers and International Trade Union Confederation [3]. In essence the report argues that there is "tremendous potential" for green jobs [3]. It goes on: "Encouragingly, the business case for greening both the economy and the job market has been growing increasingly powerful. Energy and commodity prices are surging and customers and policy makers are exerting growing pressure on businesses to adopt greener practices and production methods in order to avert dangerous climate change. The greening of the economy presents a major opportunity to start new businesses, develop new markets and lower energy costs. Last but not least it can strengthen a business' licence to operate, generating positive attitudes of both the activities and investments of firms among customers and local communities alike."

Looking at North America, there are several notable reports by organisations expressing similar optimism. The Pew Charitable Trusts conclude that, in respect of energy: "the clean energy economy, still in its infancy, is emerging as a vital component of America's economic landscape. Across the country, jobs and businesses in the clean energy economy are being driven by consumer demand, venture capital infusions by private sector investors eager to capitalize on new market opportunities, and policy reforms by federal and state lawmakers who want to spur economic growth while sustaining the environment" [4].

Similarly, reports by the American Solar Energy Society [5] and activity by organisations including *Apollo Alliance* [6] and *Green For All* show strong advocacy and support for green jobs [7].

With a focus on the energy sector, Global Insight [8] on behalf of the United States Conference of Mayors conclude: "There are many Green Jobs in our economy already, but that figure stands to grow tremendously over the coming years due to market forces, legislation, and local initiatives, or some combination thereof."

In Canada, Gallon notes that by the beginning of the 21st Century green jobs, across more than the single energy sector, were generating "approximately 2.2 percent of Canada's gross domestic product, a figure that may actually underestimate the true size of the sector." [9]

Interest in green jobs is also reported in Europe. Here Ghani-Eneland, and Renner (2009) in 'Low carbon jobs for Europe' report on trends in such jobs associated with the renewable energy sector, transport, and energy efficiency. Their estimates are that green jobs account for some 3.4 million direct jobs, while indirect jobs may add up to an additional 5 million [10]. Regarding the future they suggest that: "The number of green jobs is still a relatively small share of that total, but compares favourably with the 2.8 million jobs in polluting industries (mining, electricity, gas, cement, and iron and steel sectors). And indications are that jobs in the renewable energy sector and other green economic activities will continue to expand in the future, whereas employment in extractive and polluting industries continues to decline" [10].

In Australia there has been interest in the development of jobs in the environment (or green) sector for almost two decades. In the mid 1990s the House of Representatives Standing Committee on

Environment, Recreation and the Arts (1994) reported: “The environment industry is one of the fastest growing sectors of the global economy. Worldwide, the market for environmental goods and services is already larger than the aerospace market. While the world market for the pollution control and waste management sectors of the industry is expected to grow by at least five per cent per year, a much higher growth rate is forecast for South-east Asia which will provide substantial opportunities for Australian industry” [11].

To take advantage of these opportunities the Committee proposed 54 recommendations to support the development of environmentally related jobs; however there is no clarity as to how many were ever enacted.

At the turn of the century, and with the focus on jobs in (the Australian state of) Tasmania, similar expectations were held by that state’s Department of State Development when a six percent growth was predicted in jobs associated with sustainable development. By the mid 2000s similar enthusiasm was noted for the whole of Australia by the House of Representatives Standing Committee on Environment and Heritage (2003). They concluded that: “the real growth for environmental employment, and the real gain for Australia, lies in integrating environmental management across all levels of industry. All jobs and businesses must take on an environmental responsibility and become ‘green jobs’ and ‘green businesses’” [12].

A modest set of sixteen recommendations was made in the categories of: understanding the environment industry (essentially related to overcoming the lack of reliable and trend data); industry and government—leading ecologically sustainable development; marketing the environment industry and renewable energy; and educating and accrediting the workforce.

Generally a lack of data on environmentally related jobs has been an issue for investigators. However, in their report for the Melbourne City Council (in the state of Victoria), NIEIR was able to assemble some precise data. They identified the special role that the environment industry played in the industry of Victoria and Australia, and that it was well placed to deliver strong growth into the future. Specifically: “The industry is estimated to have produced \$363 million dollars of turnover in 2001. The indirect or flow-on benefits of this activity contributed a further \$422 million dollars locally, and another \$70 million throughout the state. The total economic value of the environment industry operating the City of Melbourne is estimated to be \$785 million. There are at least 2,080 people employed in the sector in the City of Melbourne and a further 11,500 around the metropolitan area and throughout the state.” [13]

Since the mid 2000s there has been a steady growth in publications on green jobs. A number of publications have been produced by organisations including trade unions, renewable energy companies, NGOs (both environmental and community), state and Federal governments, industry skills councils, and research organisations. The following illustrates the diversity of groups involved in this recent discussion:

- Australian Conservation Foundation
- Friends of the Earth
- World Wildlife Fund
- Greenpeace Australia
- The Climate Institute

- Brotherhood of St. Lawrence
- Victorian Council of Social Services
- Industry Skills Councils
- Connect Research
- Australian Council of Trade Unions
- Dusseldorp Skills Forum
- Australian Geothermal Energy Association
- Carnegie Corporation Ltd
- New South Wales Government
- Victoria Government
- Commonwealth Scientific and Research Organisation
- National Centre for Vocational Education Research

While there are many publications advocating for green jobs, there are several Australian reports released in 2008 and 2009 that contribute key research on green jobs in Australia. These include:

- ‘Energy [R]evolution: A Sustainable Australia Energy Outlook’ (published by Greenpeace International) [14].
- ‘Growing the Green Collar Economy: Skills and labour challenges in reducing our greenhouse emissions and national environmental footprint’ (published by CSIRO), which notes: “achieving the transition to a low carbon sustainable economy will require a massive mobilisation of skills and training—both to equip new workers and to enable appropriate changes in practices by the three million workers already employed in these key sectors influencing our environmental footprint” [15].
- ‘Green Gold Rush: ‘How ambitious environmental policy can make Australia a leader in the global race for green jobs’ where it is proposed: “In ...six key industries, the creation of strong domestic markets supported by strong climate change and other policies could result in an additional 500,000 jobs in Australia by 2030 above a business-as-usual baseline [16].
- ‘Who are the Green Collar Workers? A Definition and Taxonomy’ [17].
- ‘Skills for Sustainability’ noting there had been: “... the foresight to recognise that the skills policy response to climate change would become a pressing issue. ... (and) the *NSW Green Skills Strategy*, (was) to be implemented ... to develop relevant workforce skills for business in an environmentally constrained world” [18].

Broadly, these reports identify an immediate need to tackle environmental problems, especially climate change, and propose a range of mechanisms for working on these problems, all of which will require the training and employment of an expanding range of ‘green jobs’. To support this movement organisations like the Environmental Jobs Network, established in 2003, have emerged.

2. Green Jobs: An Abundance of Definitions

Annandale, *et al.*, ask:

- Is a recycling plant that emits air pollution a producer of green jobs?

- is an aluminium smelter that dramatically reduces waste sent to landfill, yet contributes large emissions of greenhouse gases, a producer of green jobs? and,
- are all jobs associated with ‘ecotourism’ green jobs?” [19]

Such is the conundrum of thinking about a definition of green jobs. Should the definition relate to only those jobs that are directly associated with environmental matters; for example an operative at a recycling separation plant? Should it include those jobs that may be more indirectly related; for example the workers who collect the waste materials to deliver to the recycling plant? Should the definition include the professional positions that have been involved in setting up the recycling plant (for example the waste policy developers in state and local government) and those overseeing the operation of the plant; the managers and accountants of the recycling plant, plus the scientists and engineers designing the plant equipment and uses for the recycled materials?

To date these questions have not been resolved. Some commentators are heavily influenced by climate change and the jobs associated with it and energy management. For example Pew reports on moves to a ‘Clean Energy Economy’ and the associated workers: “Our report counts the workers who manufacture hybrid cars and buses, technicians who construct wind turbines, electricians who install solar panels on homes and engineers who research fuel cell technology, but it does not include all auto manufacturers, electricians, technicians and engineers” [4].

Also concerned with energy management, Bezdek comments that: “...under the broad industry definition, an employee working in a private RE (Renewable Energy) company or for an RE&EE (Renewable Energy and Energy Efficiency) advocacy organization would constitute a RE&EE job, as would an employee of the federal or a state RE&EE agency” [20].

However, Bezdek recognises the type of complexities identified above, by Annandale *et al.* As Bezdek notes: “Most people would agree that the positions in a firm that assembles and installs solar thermal collectors would be considered RE&EE jobs. But what about the jobs involved in producing those solar panels, especially if the factory involved uses coal-based energy, one of the most controversial fossil fuels in terms of emissions?” [20].

The conclusion illustrates the embryonic state of thinking on this topic and produces a vague definition of jobs in this sector: “... the RE&EE industry encompasses all aspects of renewable energy and energy efficiency, and includes both the direct and indirect jobs created in both these sectors.” [20]

Energy management, and water management, is also a driver for the NSW Department of Education & Training [21] interest in the development of skills for green jobs across nine industries. Specific jobs are not defined, rather the emphasis is on the essential role that the vocational education and training sector will play in developing skilled workers.

A degree of focus is provided by Ehmcke *et al.* After some discussion about the nature of green jobs definitions, the report defines green collar workers in two categories: “I. Managers, professionals and technicians who work in green organisations or who have green skills and responsibilities within other organisations that may not be considered green. II. Services, clerical, sales and semi skilled workers who work in green organisations” [17].

In recognition of the complexities of defining green jobs, through their report to the Environment Institute of Australia & New Zealand and the NSW Department of Environment and Climate Change, Ehmcke *et al.* present a taxonomy of green jobs [17]. Seven broad types of green collar workers were

identified, those involved in: management, strategy, technology, policy, education, action and process. Across these the taxonomy codes green jobs according to whether they were predominantly Environmental or sustainable, and to relate to Occupation, Skills level, and industry classifications.

Without being concerned about the specifics of categorising green jobs, others, specifically in the USA, have painted a broad picture of green jobs. Arias noted: “Lucy Blake, chief executive of the Apollo Alliance, considers a green-collar job to be a blue-collar one that has been upgraded to “address the environmental challenges of our country. Sierra Club Executive Director Carl Pope defines a green job as “something useful for people, that has to be helpful to, or at least not damaging to, the environment.” And Raquel Pinderhughes...considers green-collar positions “blue-collar jobs in green business—that is, manual labor jobs in businesses whose products and services directly improve environmental quality” [22].

These perspectives, of green jobs being directly related to environmental management, are in line with the thinking of Annandale *et al.*, who suggest using “the term ‘green jobs’ to mean those that reduce the negative impact made on the environment” [19]. This simple, but still broad-reaching approach accords with international thinking as expressed by the United Nations Environment Programme. In line with the inclusiveness of NSW Department of Education & Training, UNEP comments that: “Green jobs are found in many sectors of the economy from energy supply to recycling and from agriculture and construction to transportation. They help to cut the consumption of energy, raw materials and water through high-efficiency strategies, to de-carbonize the economy and reduce greenhouse-gas emissions, to minimize or avoid altogether all forms of waste and pollution, to protect and restore ecosystems and biodiversity” [3].

Importantly the next sentence effectively defines green jobs—“Green jobs play a crucial role in reducing the environmental footprint of economic activity...” [3].

Interestingly recent concern over climate change and environmental issues generally does not seem to have advanced our thinking on what a green job may entail. Some seven years ago Greenskills Inc proposed that: “the simplest definition of a green job may be one which “reduces the negative impact made on the environment, relative to the status quo”. This broad definition would allow green jobs to be thought of as occurring across a spectrum from innovations that reduce the environmental impact of traditionally “dirty” industries (as in the aluminium smelter example), to jobs that are entirely new and have been initiated primarily to address specific environmental problems” [23].

The breadth of this definition, in covering the range of industries and occupations that are associated with environmental issues, and the flexibility it allows to encompass jobs not currently identified make it an attractive option for adoption. However, with the current and anticipated expansion in the range of industries and occupations that are involved in environmental and sustainability issues, this definition can be interpreted as covering very many jobs and, like the term ‘sustainable development’, may become meaningless [24].

Categorising jobs as those with direct or indirect connections to environmental and sustainability issues may help to focus the discussion. In this case green jobs could be defined as those where employees work:

- for an organisation that has environmental management and/or sustainability as its core business (direct connection)
- in a role where environment or sustainability is their main responsibility (even though that may not be the core business of the organisation) (direct connection)
- in a role where they supply goods or services, the intent of which is to reduce any negative impact made on the environment (indirect connection).

In developing a coherent taxonomy of green jobs, we begin to see the ways in which the transition to a green economy will be realised. Green jobs in technology, renewables and energy efficiency, and water futures are demonstrably green in nature—they directly serve our urgent objective of carbon emission reduction. Jobs in the managerial and education sector may be less visibly green in terms of skills and activities, but they involve managing and directing workers in green jobs, making forward estimates, and educating the labour force across the board. If we take the ‘simple definition’, offered above, by Greenskills, we can see a much broader inclusion of professions and fields in terms of a direct role in the ‘reduction of negative impacts’. Clear roles can be seen for all professions in terms of building capacity for the direct front line roles in energy, water and waste—from the social workers and social policy advocates who support poor communities in the transition, to the artists, writers, journalists and media specialists who document our journey to sustainable futures. In large part, this capacity relates to the need to facilitate change, whether through explaining and debating imminent changes, persuading communities and individuals to ‘buy in’, or to supporting them to move through legislative and practice changes.

A focus which is limited to technical and vocational training omits the wider upskilling and conceptualisation required to develop a coherent understanding of the capacity required for green futures. What is now becoming clear is the role of universities as gatekeepers of professional education. Graduates of the professions exit into a huge range of sectors and fields, not necessarily in direct relation to their degree of origin. As we reengineer our social arrangements for carbon pollution reduction, many of these professionals will be in the front line of the response and the challenge. Universities’ graduates need transferable skills to adapt to the many, varied and increasing demands of the drive for sustainability [25,26].

3. Current Green jobs

3.1. International Perspective

Green jobs are already an identifiable contributor to employment statistics and national economies. Within the ‘clean energy’ sector alone UNEP recorded some 4.6 million people involved worldwide (see Table 1), with one million of these jobs involved with improving building energy efficiency. UNEP cite a study commissioned by the American Solar Energy Society that identified 3.5 million direct jobs and 4.5 indirect jobs in improving the energy efficiency of buildings, but believe that these are overstated [3]; ASES also suggests that 40 million people will be employed by the clean energy sector in 2030 [20]. On top of these UNEP note the ‘induced’ manufacturing jobs created by demand for efficient products [27].

Table 1. Estimated employment in the in the renewable energy sector, 2006 (selected countries) (source UNEP 2008b).

Renewable Energy Source	Employment world-wide (where data are available)	Employment in Selected Countries	
Wind	300,00	Germany	82,100
		United States	36,800
		Spain	35,000
		China	22,200
		Denmark	21,000
		India	10,000
Solar Photo-voltaic	170,000*	China	55,000
		Germany	35,000
		Spain	26,400
		United States	15,700
Solar Thermal	624,000+	China	600,000
		Germany	13,300
		Spain	9,100
		United States	1,900
Biomass	1,174,000	Brazil	500,000
		United States	312,000
		China	266,000
		Germany	95,400
		Spain	10,300
Hydro-power	39,000+	Europe	20,000
		United States	19,000
Geothermal	25,000+	United States	21,000
		Germany	4,200
Renewables combined	2,332,000+		

* Assuming that employment in Japan's PV industries is similar to that in Germany.

Some of these manufacturing jobs may have been associated with the 'environmentally friendly production' sector which, in the US and according to Pew had a growth rate of 67% between 1998 and 2007. The respective rates for 'clean energy' and 'energy efficiency' sectors were 23% and 17%. All this indicates a strong trend in the establishment of green jobs, as Pew notes: "... between 1998 and 2007, clean energy economy jobs—a mix of white- and blue-collar positions, from scientists and engineers to electricians, machinists and teachers—grew by 9.1 percent, while total jobs grew by only 3.7 percent." And "...despite a lack of sustained policy attention and investment, the emerging clean energy economy has grown considerably—extending to all 50 states, engaging a wide variety of workers and generating new industries." Their estimate of jobs associated with the clean energy sector was that by 2007 over 68,000 businesses had generated over 770,000 jobs [4].

In the European Union the situation is similar. Ghani-Eneland, and Renner estimate that: 'there are close to 400,000 jobs in renewable energy (direct and indirect), some 2.1 million in efficient transportation (direct only), and a highly conservative 900,000-plus (again, direct only) in energy efficiency goods and services. These add up to some 3.4 million direct jobs altogether. Indirect jobs

not accounted for above may be in the order of at least an additional 5 million. Other energy efficiency areas such as efficient appliances, lighting, and other equipment would add more jobs to the total.’ [10]

As we see above, the transport sector also contributes green jobs. In the mid 2000s there may have been only some 250,000 jobs world-wide in the manufacture of fuel-efficient, low-pollution and low-emissions cars, but UNEP reports over 5 million jobs in the railways in China, India and the European Union alone, and millions more in public transport worldwide. Further, retrofitting diesel buses and building compressed natural gas (CNG) or hybrid-electric buses in India adds some 18,000 new green jobs [3].

More broadly, UNEP acknowledge green jobs in the steel, aluminium, and concrete industries generated from activities to reduce the industries’ environmental impacts. UNEP state that ‘Greening basic industries is difficult and fewer than 300,000 jobs in iron, steel and aluminium can be considered to have any “shade” of green.’ UNEP discuss recycling jobs but conclude that it is difficult to classify them as green jobs because many recycling practices still have adverse environmental and social impacts; UNEP also argue that It is also difficult to measure agriculture and forestry green jobs [3].

In the management of solid waste, recycling plays a key green role. According to UNEP recent reports put the number of recycling and remanufacturing jobs in the United States alone at more than 1 million. Precise figures are difficult to obtain, but in China, an estimated 10 million people are employed in all forms of recycling. Similar difficulties with the collection of statistics are found regarding agriculture, although UNEP refer to organic farming registering sales reaching \$100 billion in 2006, indicating that it is beginning to register an impact [3].

Looking at an overview of the range of green jobs types in Canada at the end of the 1990s, Gallon commented that: “the environmental sector is the third largest in the country, after the pulp and paper and the chemical industries. With 221,000 workers, the environmental sector employs more people than either the steel industry or the oil extraction sector, and rivals the large resource extraction and manufacturing sectors for job creation” [9].

Gallon also notes that there is a ‘pool’ of what could be called green jobs, those that have beneficial impacts on the environment but are not currently identified in official government statistics. These types of jobs include: green architects, industrial process engineers that improve production efficiencies, bicycle manufacturers, and anyone who telecommutes instead of drives to work. Counting these jobs in with those currently identified could double the number of identifiable green jobs.

3.2. Australia

Annandale *et al.* note that: “the research studies introduced earlier make it clear that the growth in green jobs has been much stronger than growth in the general business sector over the course of the last eight years”, (to the early 2000s) [19].

Nonetheless there is limited data on current green job employment in Australia. According to the CSIRO: The Australian Bureau of Statistics gathers and reports figures on employment by occupation group and industry, unemployment and labour force utilisation, but provides little insight into the availability—or scarcity—of skills and the wider supply dimensions of energy and water sensitive design and implementation across different economic sectors [15].

The ACTU and the ACF have compiled broad statistics on green jobs employment in a joint report titled *Green Gold Rush*. According to ACF & ACTU (2008) 112,000 people are currently employed in six key green markets: renewable energy, energy efficiency, sustainable water systems, biomaterials, green buildings and waste and recycling. Through ‘the right policy settings’ this figure could grow to 847,000 jobs by 2030, and a \$227 billion increase in the value of these markets from \$US15.5 billion to \$243 billion. The report argues that this growth will come about through reform of Australia’s ‘innovation system’ through direct government investment in research and development, incentives for private investment, and ‘developing environmental knowledge and skills’ [16].

Another view on the estimate of green job numbers comes from predictions of job possibilities. Although using very broad categories of *Environmental and Agricultural Scientists*, and *Environmental and OH&S Professionals*, the Department of Education, Employment and Workplace Relations [DEEWR] reported (in 2008) that these categories had some 300,000 employees in 2007 and a growth of some 3,500 over the previous five years, and future job prospects expected to be ‘good’ [21].

Green jobs have also been associated with local governments. Between 1998 and 2008 the percentage of local government authorities (LGA) in Victoria reporting environmental policies, covering a wide range of issues, doubles for some issues and increased by up to ten times for other issues [28,29]. To support these, and other green activities, the number of LGAs with at least one staff member dedicated to environmental issues, and funded through council budget, has increased from 73% in 2002, to 94% in 2008. (1998 data were not available). Responses to the MAV survey also noted that the major drivers for council activity on environment matters are community expectations; an understanding of the need for action within the LGA; external resources; councillor understanding of the need for action and a desire within council to lead by example; a result of legislative requirements; and the need to undertake specific environmental activities due to the absence of action by other bodies. This interest is demonstrated through the budgets of local authorities. The Australian Bureau of Statistics (ABS) indicated that Australian local governments were spending in the order of \$1.6 billion on environmental protection, in the late 1990s [30]. As Wild River points out, in 2002–2003 environmental expenditure by local governments of \$4.1 billion accounted for more than half of total environmental spending across Australia’s three spheres of government [31].

4. Expectations for Green Jobs

4.1. International Perspective

There are more data available on future employment and skills trends for green jobs than on current green job employment numbers, particularly in Australia. However, as noted by Hatfield-Dodds *et al.*, predicting future demand is difficult due to the lack of existing data on green jobs and training. Based on this review, data from future models vary considerably, however all models show an increase in demand for green jobs as a result of changes in market and regulatory environments from a ‘greener economy’ [15].

Significant growth in the number and range of green jobs is foreseen. Projections for international green job growth have been identified by UNEP in the sectors of energy efficiency, transport, basic industry and recycling, agriculture and forestry, and renewable energy [3]. Across EU, USA, Canada

and India the forecast is that by 2030, as a result of energy efficiency requirements in building construction and maintenance, over 4.5 million green jobs will be needed. Likewise over 230,000 employees are expected to be directly involved with the manufacture of 'green cars' across the EU, USA, Japan and South Korea [27].

A modelling exercise [10] estimated that there could be 1.7 million net jobs by 2010 in the EU and 2.5 million by 2020, covering jobs in fields such as:

- wind power
- solar photo voltaic
- solar thermal
- bioenergy
- vehicle fuel efficiency
- hybrid electric cars
- public transport
- car sharing
- bicycles
- rail
- buildings
- lighting
- combined heat and power

Similar types of jobs have been identified by Pew [4]. For instance, in regard to their category of 'environmentally friendly production' they identify green jobs covering:

- transportation—includes jobs that produce hybrid diesel buses, traffic monitoring software and liquid biofuels.
- manufacturing—covering chemists who produce environmentally sound packaging, equipment and surface cleaning products that are less caustic than traditional products.
- construction—involves workers who produce and install green building material (e.g., alternative cement and manufactured wood products made from scraps) and consultants who provide green building design and construction services.
- agriculture—includes plumbers and technicians who install water efficient irrigation systems, chemists who design alternative pest controls, and consultants who provide agricultural sustainability planning.
- energy production—involves people who design and apply cleaner technologies (e.g., gasification, pyrolysis, and carbon capture and sequestration).
- materials manipulation—covers product designers and engineers who develop biodegradable products.

Workers in these groupings will take some time to have an effect on production of goods and services, so there will also be the need for green workers with 'conservation and pollution mitigation skills'. This group will include: 'Trained workers safely (who) remediate hazardous materials from industrial sites; scientists and technicians (who) develop, install and supply products to capture and treat noxious greenhouse gases and pollutants; machinists and system operators (who) treat water and

waste; and environmental consultants (who) help companies and governments improve emissions monitoring, water conservation and recycling' [4].

4.2. Australia

In the closing years of the first decade of the 21st Century there has been a lot of interest in the role that green jobs will have in assisting both environmental problems, especially climate change, and national economies hit by the 2008 'global financial crisis'. As a consequence many organisations have produced forecasts related to the need for more resources (workers) to be involved, and the potential for growth in green jobs. The following provides an overview of key statistics from models predicting future Australian trends in green jobs; while climate change and energy management are frequently the focus of these forecasts, potential growth in a range of sectors is identified:

- According to the Climate Institute's 2009 report *Clean Energy Jobs and Investment in Regional Australia*, 15,000 construction jobs will be created if all proposed power stations and associated infrastructure in regional Australia proceed. 7,291 additional construction jobs by 2020 and 7,600 indirect maintenance, service and manufacturing jobs will be created as a result of this renewable infrastructure.
- Greenpeace & European Renewable Energy Council undertook modelling of what they termed an 'Energy [R]evolution Scenario' that predicts 'a net gain of between 33,700 and 57,500 jobs' [14]. This will be achieved through 16% cuts in electricity consumption by 2020 through energy efficiency, coal power phased out by 2030, and a 40% increase of renewable energy by 2020.
- The WWF in partnership with Australian Geothermal Energy Association and Carnegie Corporation Ltd produced two reports titled the *Power to Change*; one focused on geothermal energy, and the other on wave energy. The reports predict that 3,800 full-time equivalent jobs will be created by 2020 from installing 2,200MW of geothermal energy capacity [32], and 3,210 direct and indirect jobs will be created from 1,500MW of wave energy capacity by 2020 [33].
- CSIRO and Dusseldorp Skills Forum modelling predict that 230,000 to 340,000 new jobs will be created through more sustainable practices. These jobs will be created in the transport, construction, and agriculture, manufacturing and mining sectors [15]. This includes 33,000 new jobs will be created in manufacturing, '77,000 jobs in transport, and 145,000 jobs in construction over ten years' [15].

This jobs growth is anticipated to come about as a result of several factors, many of which are exacerbated by climate change. The wide range of sectors in which green job growth is possible is encouraging for those concerned about environmental management; equally encouraging is the range of organisations that have shown concern about development of green jobs, as indicated in the following:

- According to the Victorian State Government's *Climate Change Green Paper*, green job opportunities will increase in the following areas: 'Green buildings and urban design, Water efficiency and water markets, Lower emissions technology and renewable energy [and] development of the Australian carbon market' [33]. Green job opportunities will also arise from the: 'Design and construction (in relation to energy and water efficient buildings and infrastructure, renovations and retrofits, and the installation and maintenance of efficient

appliances and machinery), Restructuring of the energy system and the introduction of renewable energy, Developing alternative transport systems [and] Changing the ways in which food is [33].

- CSIRO's research for Dusseldorp Skills Forum lists the following jobs as important for the green economy: 'planning and design; business leadership and entrepreneurship; project management and procurement; specific business management expertise (such as for architectural practice, broad acre farming, fleet management, specialist manufacturing or retail); trade skills (such as green plumbing, construction of energy efficient buildings, renewable energy, low input gardening); assessment of project requirements (such as specification of inputs, system specifications, access to finance, approvals requirements, total costs) and outcomes (such as water and energy use, efficiency, market value); [and] marketing and communication' [15].
- *Environmental sustainability—An Industry Response 2009*, a report by the Industry Skills Councils (ISCs) claims there will be emerging opportunities in emissions monitoring, auditing and reporting skills, design and development, risk management and environmental market research roles [34].
- Allan Consulting Group, in a report to the Victorian Department of Innovation, Industry and Regional Development, claims there is a 'core set' of 'climate winning' industries that will benefit from increased carbon regulation. These include: 'gas; forestry (*i.e.*, carbon sink enhancement); energy efficiency; sequestration technologies; renewable energy; and crops due to shifts in relative costs and biofuel opportunities' [35].

This overview indicates an exciting future for green jobs, in terms of both the variety of jobs and the size of the workforce. However, this will not eventuate unless people are trained, or retrained, so that they have the skills needed to undertake their jobs; and in these jobs people will increasingly be required to demonstrate a range of skills in addition to specific knowledge and technical skills.

4.3. Skills Associated with Green Jobs

Generally, in the key reports we have reviewed, the focus is predominantly on vocational skill training and manual jobs. Very little is said about green professions; a point to which we will return. Overall, the majority of the reports and publications reviewed emphasise skills that are associated with 'clean energy', and call for investment and/or development of training and education to build the green skills needed for the new low carbon economy.

The broad scope of discussion about green jobs skills is established by UNEP. Their report *Green Jobs: Towards Decent Work in a Sustainable Low-Carbon World* warns that vocational training and qualified professionals are critical for ensuring positive environmental and economic outcomes that accompany the transition to green economy: 'Without qualified entrepreneurs and skilled workers, the available technology and resources for investments cannot be used or cannot deliver the expected environmental benefits and economic returns. Endeavours to close the current skills gap and anticipate future needs are essential for a *transition* (emphasis added) to a green and low carbon economy. An emphasis on the high end of skills and education would be misplaced. Training what might be termed "green collar" workers is just as important' [3].

However, the range of needs in the green skills arena is broad. In the US the discussion associated with the clean energy economy has generated a list of skills focused on energy management, but which still relate to a range of needs. In this case Pew discuss the range of skills needed in five areas: clean energy, energy efficiency, environmentally friendly production, conservation and pollution mitigation and training and support [4].

‘Clean Energy skills’ will be associated with a variety of workers: ‘Electricians, electrical engineers and plumbers help install new energy systems, while plant operators ensure that renewable sources such as wind and solar are being converted to electricity. Mechanics rebuild ailing energy infrastructure by installing sensors and controls that monitor and distribute clean energy more effectively (*i.e.*, making the grid smarter). Researchers and technicians perfect and implement battery technologies that improve how we store and distribute clean energy’ [4].

The capabilities these workers will need to exhibit include installation aptitude, *i.e.*, electrical and plumbing trades skills, operation and maintenance, competencies in operating plant and mechanics, together with research and development abilities—encompassing science, technology, engineering and mathematics skills:

‘Energy efficiency skills’ will be associated with professionals having an understanding of energy efficient products, software engineering, hardware engineering and product design skills, electricians and builders with energy efficiency. The context for these skills is that: ‘Engineers develop energy-efficient lighting, meters, software programs and other products that help curb and monitor energy usage, while electricians and others install them in homes, businesses and government buildings’ [4].

In addition there is the need for ‘Training and Support skills’. Unlike the skills associated with many of the above situations (*i.e.*, mainly vocational and technical skills), training and support skills will involve many professional groups, including: ‘Financial analysts and consultants specialize in clean tech investments, lawyers and paralegals provide legal services, researchers and engineers develop new energy generation technologies, and vocational teachers train new workers for the clean energy economy’ [4].

The final point serves to emphasise the imperative of training and education to develop the range of skills needed by green workers. The pressing need for green jobs also identifies the need for transformation in the education sector to be in a position to provide the required skills. As stated by the Victorian Government: ‘Having people available and willing to undertake training is only part of the solution; the qualifications being delivered must be suited to the changing needs of the Victorian economy. We will need to revise existing qualifications to incorporate green and climate change components, introduce new qualifications to respond to emerging technologies and new occupations, and make sure that we have qualified teachers in the relevant areas’ [33].

Specifically on the issue of teaching the green skills, ISC [36] acknowledge the need for teacher training to deliver new training programs, and for these to include new learning approaches like ‘experiential learning, action research, project based learning’. In essence this represents yet another set of skills related to green jobs [37,38]. However, when discussing skills requirements to tackle climate change, the Garnaut Review argues that ‘In industry, formal education and reskilling courses are generally suitable for addressing the lack of skilled professionals, such as engineers’ [39]. These skills ‘help individuals to identify the energy and other costs affected by a carbon price and respond to it’ [4].

Yet they may be insufficient to help workers meet the sort of challenges suggested in the list of requirements identified by Pew, above [40]. Stibbe & Villiers-Stuart recognise the same types of skills, gathered under a heading ‘sustainability literacy’, which has characterised the skills reform agenda for three decades. The capacity needed to work and act for, and in, change, is as it ever was. Only the nature of the change is different [41].

Development of skills capabilities is also an issue for Vincent & Wakeham, who recommend a ‘roll out of a major green-job apprenticeship program; Development of tertiary courses in low-carbon industries and businesses; Opportunities for green on-the-job training and; Education and up-skilling in specialist sectors, such as electricians and plumbers’ [34]. Specific skills are also called for by ISC, where the suggestion is for industry practices that entail ‘personal responsibility, analysis skills, for example product lifecycle analysis, transparency, including compliance auditing and reporting, conservation, and waste management’ [34]. According to the ISC, environmental sustainability ‘requires a climate of innovation, collaboration and leadership’ [35].

Broader types of ‘up-skilling’ has been proposed by Allen Consulting Group in relation to greenhouse and climate change programs in the Asia Pacific region. They suggest that for a greener economy green workers need: legal and financial service skills; engineering and project management; and monitoring and evaluation skills [15].

Perhaps this overview of skills for green jobs can be summarised by the scope of points covered by Hatfield-Dodds *et al.* Important green collar skills include:

- planning and design
- business leadership and entrepreneurship
- project management and procurement
- specific business management expertise (such as for architectural practice, broad acre farming, fleet management, specialist manufacturing or retail)
- trade skills (such as green plumbing, construction of energy efficient buildings, renewable energy, low input gardening)
- assessment of project requirements (such as specification of inputs, system specifications, access to finance, approvals requirements, total costs) and outcomes (such as water and energy use, efficiency, market value)
- marketing and communication [42]

These points are beginning to touch on the areas of broad, or generic skills. Academics working within the education for sustainability movement have identified a number of key, *transferable* skills which enable graduates to function as sustainability practitioners [43]. These skills include critical thinking and decision making, working in multidisciplinary teams, recognising and measuring impacts, self awareness and reflection and complex problem solving [44,45]. These attributes, if fostered across university curriculum, will lead the dramatic paradigm shift which will enable our transition to a green economy and a sustainable future. Universities, along with all post-compulsory training organisations, must be exhorted to recognise the depth, breadth and interrelation of the notion of ‘green workers’.

In essence, many skills are required, ranging across vocational and professional areas of expertise. From this it is clear that at this stage while many have argued for the urgency of tackling environmental problems, especially climate change, we are not in a position to be clear about the skills

that these green workers will need. There are many proposals, too many perhaps. What we now need is some work to identify the key skills. We need to discover whether there are skills that are applicable for particular types of green jobs, or whether there are skills that are applicable to all green jobs.

4.4. Insights in the Direction of 'Green Jobs'

The information we have been able to assemble about green jobs shows that there are four key issues that need to be considered and researched if the phenomenon of 'green jobs' is to play a considered role in environmental management, climate change management and sustainable development.

First, there is no clear understanding or agreement about a definition for green jobs. As we have discussed much of the recent focus has been around jobs in energy management, however, the proposal by Greenskills Inc that "a green job may be one which "reduces the negative impact made on the environment, relative to the status quo" has the advantage of being broad enough to encompass the wide range of environmental and sustainability issues [45]. However, associated with such a definition needs to be the consideration of whether it will cover those jobs with both direct and indirect connections to environmental issues (as discussed previously).

Second, there has been much discussion about green jobs in relation to vocational jobs, in the trades, but this has been to almost the complete exclusion of recognition of the contribution that jobs in the many professional areas make to the range of green jobs. This issue is related to that of a definition for green jobs. For future discussion around this topic it is clear that we cannot limit ourselves to thinking that green jobs are only those that have a vocational focus. Green jobs must encompass those in all fields of employment; professional and vocational.

Third, and also related to the definition of green jobs, and the coverage of vocational and professional employment, is the issue of the skills that are required in these jobs. Here there may be a need to distinguish between vocational and professional areas. It could be argued that vocationally related jobs require a concentration on the very practical skills; whereas professional positions need to capture the broad conceptual and management skills. However, more research is needed to understand exactly what are the skills workers will need in the near future to engage with all those environmental issues that green jobs proponents have identified.

Fourth, there is much speculation about the potential increase in the variety and number of green jobs, but there is generally a limited data base of current green jobs upon which to base firm projections. Without a reasonable data base related to the current range of green jobs and the numbers employed, we do not have much of a starting point for speculation about the future. It is most unlikely that we could now try to delve into the historical data and develop a data base. However, we can establish a data base to monitor green jobs from now on. The dimensions of such a data base will need to be researched and proposals developed to implement it. But of course, accounting for green jobs requires that we know what we are counting; *i.e.*, we need a definition of green jobs.

Our discussion of green jobs in this paper and the four points above serve to highlight a number of issues. It is clear that there is considerable effort being put into the expansion of green jobs in many countries, including Australia. However, without a better and more consistent understanding of what we mean by a 'green job' we will perpetuate the current confusion. We also run the risk of losing the

opportunity to demonstrate the breadth of the field and its importance to workforces and national economies. We hope our contribution will lead to others helping to consolidate a definition of green jobs, and to researching the related skills and data base needs.

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