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The transition from fossil fuels to a low carbon circular economy in Australia:

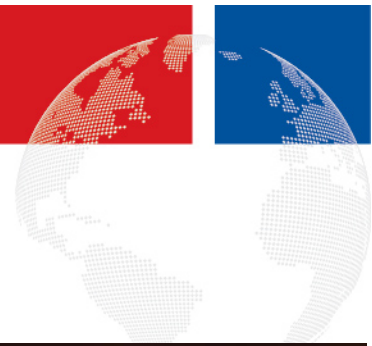
An environmental management perspective

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We Deliver

Today's discussion



- Introduction - 2015/16 renewables in Australia
- Renewable resources in Australia
- Environmental issues
- Environmental consultancy
- Transferable environmental skills
- Environmental approvals
- Employment and future forecasts
- Current skillsets and training
- Conclusions and development



Introduction – A brief context



- Renewable energy provided 14.6% of Australia's electricity in 2015 - 6.7 million homes. An increase of 13.5% from 2014
- Australia's existing network is old and highly carbon intensive and highly dependent upon carbon intensive fuel sources
- Momentum towards renewables is growing across all sectors
- Target has been set to increase to 23% of Australian electricity in 2020
- There is a demand to shift from fossil fuels to efficient low energy systems which requires a shift in skills focus.

Introduction – A brief context



- Australia is at the early stages of transition
- Driven by current framework of Renewable Energy Target
- Majority of RET targets will be met by onshore wind, solar PV alongside LEDs, hybrid and electric vehicles & improved battery technology
- Complemented by coal to gas switching
- Improved energy efficiency and waste to energy streams also to contribute

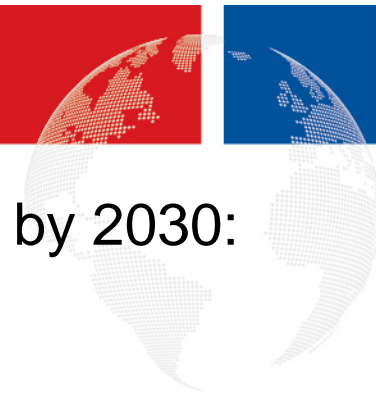
Development:

- 5 new wind farms completed in 2015
- 8 solar farms larger than 1 MW capacity
- 2 of the 3 largest solar plants in the country
 - Nyngan and Broken hill (AGL/First solar) operational during 2015
 - Moree Solar Farm launched earlier this year
 - All received support from Australian Renewables Energy Agency

Australia vs EU environmental approvals



- EU countries' development of renewables is maturing and focus is shifting away from R&D and into full blown operations such as offshore wind.
 - Approvals vary slightly between states but overarching environmental management falls under EIA directive, Habitats Directive and Birds Directive alongside the Water Framework for some hydro schemes.
- Australian states have different approval mechanisms and incentives to drive renewable development... this will change as the economics become increasingly viable moving away from fossil fuel based sources.
 - Main driver is commitment from governments and political will power, with uncertainty in investment restricting opportunities for development in growth.



Over 33,980 new jobs in electricity sector will be created by 2030:

- 7,619 permanent ongoing jobs
- 20,700 construction jobs
- 5,650 manufacturing jobs.

The vast majority of these jobs will be in renewable energy.

Renewable Technology	Ongoing jobs	Construction and Installation Phase employment	Manufacturing jobs supported	Total
Hydro	22	286	33	342
Wind	635	9,097	4,549	14,281
Bioenergy	1,175	711	5	1,891
Geothermal	2,881	1,686	179	4,745
Large-scale solar	1,469	3,240	216	4,925
Small-scale solar	634	5,191	161	5,986
Solar hotwater	0	3,575	886	4,461
TOTAL	6,817	19,271[^]	5,655[^]	31,742

[^] This is the peak annual workforce for all technologies, not the sum of individual peaks for each technology

Environmental Consultancy in Australia



Estimated size of the overall environmental market: \$35M*

Main drivers for environmental management in the renewables market:

- Approvals for new and existing energy plants and technological advances
- Operational and construction compliance
- Amendments to renewables regulation
- Environmental inputs into design
- Key focus for renewables is new greenfield and brownfield development currently very small market for environmental management.

* Based on Environment Analyst Figures 2015 number of people and estimate of renewables as a portion of the climate and energy sector

Current resources

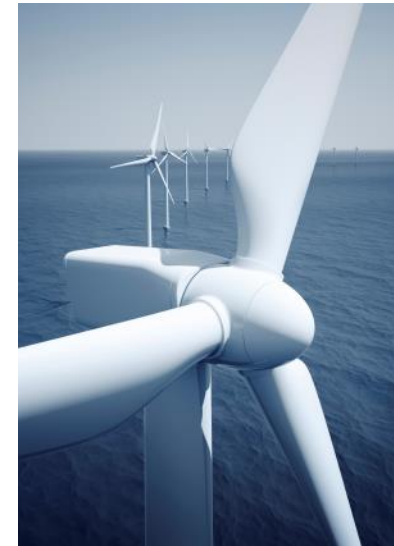


- Widely distributed across the country (except hydro) and wind which is growing rapidly
- Constrained by high transformation cost relative to other energy sources, new technology and long distances from markets and infrastructure
- Cost largely up front with no ongoing fuel cost
- Cost decreasing with most significant cost improvements in wind and solar- some up to 80% from 2009.





- Some of the best in the world
- Located from western through to south-eastern coastal regions and extending hundreds of kilometers inland
- Rapid expansion, encouraged by government policies, notably the Renewable Energy Target
- Five wind farms became operational in 2015 adding 196 turbines and 380 MW capacity
- Increased Australian wind industry to 76 wind farms combined capacity of 4187 MW (2062 turbines)
- 4.9% of total electricity generated in 2015.



Wind – Environmental Management Issues



- Land use
- Visual impacts
- Ecological impacts (including bats and birds)
- Public health
- Life cycle emissions
- Social, Cultural and Economic Impacts





- Some of the best solar radiation resources in the world
- Large areas of high solar radiation
- Commonly in areas not close to major population centers
- 2.4% of total electricity generated in 2015



Solar – Environmental Management Issues



- Land disturbance/Land use impacts
- Direct impacts to natural resources such as soil, water and air
- Ecological impacts
- Visual impacts
- Social, Cultural and Economic Impacts.



Geothermal Energy



- Geothermal energy is an emerging industry in Australia, with exploration in all states and the Northern Territory.
- Several companies in advanced stages of exploration, presently there is no commercial production of geothermal energy in Australia.



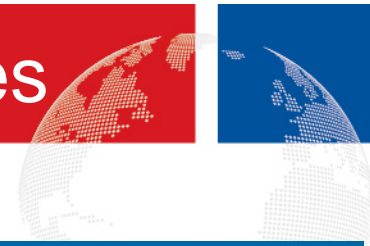
- Water Quality Impacts
- Air Quality
- Land use
- Life cycle global warming emissions
- Social, Cultural and Economic Impacts.



- Focused predominantly in Tasmania
- Development and feasibility assessments underway for disused gold mines in Queensland e.g. Kidston
- 5.9% of total electricity in 2015.



Hydro – Environmental Management Issues



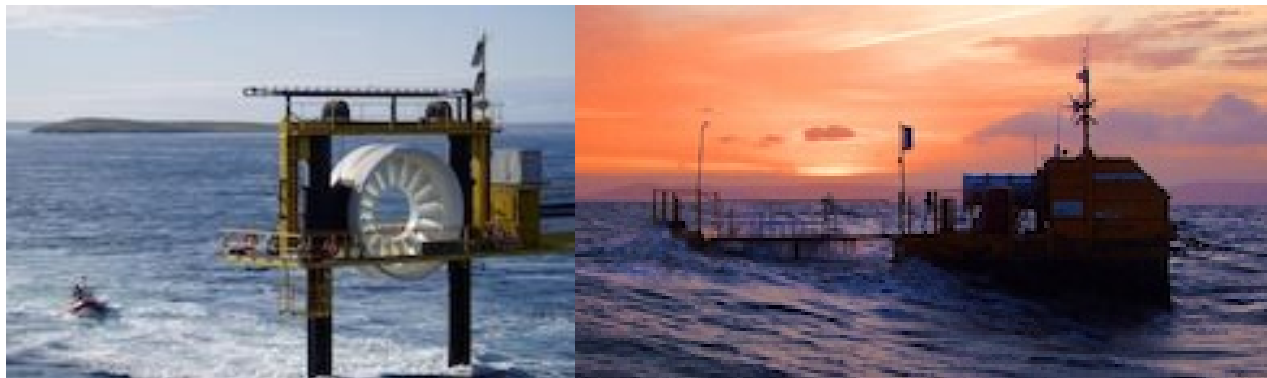
- Land use
- Ecological impacts
- Life cycle emissions
(vegetation and soil decomposition)
- Social, Cultural and
Economic Impacts.



Ocean Energy: Wave/Tidal



- Best wave energy resource along its western and southern coastline, especially in Tasmania
- Best tidal resources, on the other hand, are located along the northern margin, especially the north-west coast of Western Australia
- Two plants operational...minimal input into the grid.



Wave/Tidal: Environmental Management Issues



- Ecological impacts including impacts to marine mammals
- Underwater Noise
- Alteration in marine systems(sediment and hydrologic regime)
- Alteration in use of the sea e.g. fisheries
- Life cycle emissions
- Social, Cultural and Economic Impacts.



- Significant potential energy resource in Australia
- Three existing pilot plants on converting biomass to bio-crude – biosolids, algae and forestry residue
- Biodiesel industry, small and limited by available oils, mostly based on used cooking oil, animal fats and some oil seed production
- Ethanol from molasses in Queensland and NSW
- Furfural plant in northern Qld as a bio-polymer feedstock
- New catalyst developed to make bio-crude by pyrolysis (including renewable jet fuel)
- 1.3% of total electricity in 2015.

Bioenergy: Environmental Management Issues



- Emissions
- Water and resource use
- Ecological impacts
- Social, Cultural and Economic Impacts.



Energy production from renewables* statistics & average growth



Defined as the total amount of primary energy produced in the Australian economy as measured before consumption or transformation.

Source Dept Industry and Science (2015) Aust. Energy Stats Table A and D	Average annual growth (%) over previous 10 years
Renewables	2.4
Bio	-0.3
Hydro	1.9
Wind	31.3
Solar PV	58.3

*Australian Energy Statistics 2015

- Existing consultancy experience in linear infrastructure
- Existing knowledge of development of remote locations
- Site specific technical knowledge
- Approvals and permitting for renewable energy development
- High degree of variability between approvals mechanisms between states which requires specific skills

Example approvals regime for renewables



South Australia:

- biggest investment in Australia over past 10 years
- stability from state government policy and developers
- ongoing policy to encourage development, such as access to land.

Victoria:

- Previously little encouragement from policy makers or state government
- Then...most recently June 2016, the Victorian Government commitment targets of 25% by 2020 and 40% by 2025.
- Ambitious estimated \$2.5 billion of investment and an additional 4000 jobs in Victoria's renewable energy sector. Including the requirement for substantial environmental requirement and input....watch this space.

Employment breakdown



- Overall number of people employed 14,020* in 2014-15 reduced from peak of 19,020 in 2011-12
- Largest employment in solar energy with 53% of employment
- Wind (mainly installation) is volatile and subject to periods of investment has grown from 6% to 12% in 2013-14
- Hydropower stable
~10% increasing slowly.



Source: ABS 2016

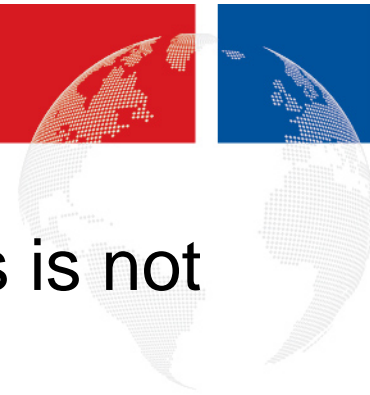
Environmental management in renewables



- Environmental roles in renewables roughly 4% of environmental consulting market
- Varies between states and territories dominated by solar power
- 200 renewables projects planned to meet Renewable energy target (RET) of 23% by 2020 which will require environmental inputs and advice
 - most projects are solar and wind.
- Large potential for development of existing brownfield sites e.g. fossil fuel plants or mining areas to be redeveloped for renewables as well as upgrade of existing infrastructure which will all require environmental consideration.

*Environmental Analyst 2015

Current training available in renewables



Current thinking is that demand in renewables is not being fully met (Clean Energy Council 2009)

Types:

- On the job- trades
- Renewables courses (specific Australian courses highly varied and developed for key areas)
- Some specialist courses dedicated to renewable development e.g. Murdoch Uni/RMIT
- Environmental management can be applied across all energy sectors

Existing skills



- Environmental expertise in Australia highly developed across all sectors especially in oil and gas and mining, global leader in many areas
- This expertise covers, ecology, geology and hydrology and is applied to a range of developments and technologies
- Well developed expertise in approvals state by state for large scale energy
- Skills also apply to infrastructure and aiding engineering design for remote locations which can be directly applied to renewables in many areas
- Limited specific niche environmental experience for large scale infrastructure environmental management in renewables in Australia (except wind) developing market e.g. underwater noise assessments for tidal systems

Conclusions

- Emerging industry with strong growth forecasts with environmental considerations being a critical component of future development
- Australia has highly transferable long term skills and global leading experience in environmental management for energy projects and infrastructure
- Environmental market can support projects and has existing experience in key areas with technical knowledge developing with help from global markets in niche areas
- Reskilling is underway where there are opportunities and a highly adaptable mobile workforce
- Difficult to predict future environmental management within the renewables sector due to government uncertainty
- The population are keen to move towards cleaner fuel and the employment that goes with it following global shift.

