

Cleantech in the Built Environment – Today and Tomorrow

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ABSTRACT

The cleantech sector is wide ranging and covers many technologies that are already employed in all aspects of the build environment, from transport to buildings. The paper will initially consider a definition of cleantech and explain why some aspects are included in this definition and others are not.

The paper will then consider examples of technologies being deployed in projects today. This will look at energy efficiency technologies, biomaterials, distributed energy and water systems and a range of transport technologies.

The paper will also consider the many clean technologies that are being developed around world and look at which of these might have the greatest chance of widespread deployment and what the key success factors will be to ensure this.

As a conclusion, the paper will review what technologies we are likely to see adopted in Australia over the next five to ten years.

Cleantech in the Built Environment – Today and Tomorrow

PAPER

The cleantech sector is wide ranging and covers many technologies that are already employed in all aspects of the build environment, from transport to buildings. The paper considers a definition of cleantech and explains why some aspects are included in this definition and others are not, reviews the drivers of cleantech and considers the current and likely future cleantech developments both globally and in Australia.

Cleantech Defined

Cleantech is the word of the moment. Everywhere you turn it is being used. Law firms, accountants and banks all have cleantech groups. Governments have cleantech taskforces.

These groups often fail to define the term they are using. One definition that we have adapted from the US research group, CleanEdge, encapsulates the spirit of cleantech:

Economically viable products, services and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources and cut or eliminate emissions and wastes.

More concisely cleantech contains products and services that have ‘*economic and environmental benefits*’. The cleantech sector in Australia has been profiled recently in the Australian Cleantech Review. The analysis provides some interesting patterns in the sub-sectors with the greatest activity levels and the regions in which they are based. As a sector, the companies had a combined revenue of \$9.2 billion and employed over 13,000 people. They raised a total of \$2.3 billion in new funds during the 2009 calendar year.

Sectors that appear to fit into the definition of cleantech without dispute include:

- Renewable energy – wind, solar thermal and photovoltaics, wave, tidal, hydro, geothermal, biomass and biogas;
- Water technologies that increase efficiency;
- Energy efficiency, green buildings and biomaterials;
- Waste management and recycling;
- Energy storage and fuel cell technologies;
- Low emission vehicle technologies; and
- Environmental Services.

Other sectors are controversial with some including them within cleantech by reason of their environmental benefits whilst others reject them because of insufficient positive environmental benefits or too many perceived negative impacts. Examples are set out below.

- **Biofuel** is an emotive subject. Seen by some as the saviour to high oil prices and energy security issues, but by others as the cause of rising food prices, food riots and increasing monoculture. Research into cellulosic and algae-based biofuels, if successful, may remove many of the downsides of current technologies and this is therefore included in our definition.
- **Carbon Trading** is clearly driving much of the investment behaviour in cleantech, but it is questionable whether the act of trading has any direct environmental benefits. Through facilitating investment in environmentally beneficial outcomes, it can however be seen as a key part of the cleantech chain that is also included in our definition.
- **‘Clean’ fossil fuels** include natural gas, coal seam methane, underground coal gasification, gas to liquids, carbon capture and storage and clean coal technologies. These are often included in clean energy indices and funds due to their reduced emissions profiles. However, despite the ‘clean’ tag, they remain fossil fuel energy sources and are therefore, at best, only transition resources or technologies and is excluded from our definition.
- **Nuclear power**, along with its associated uranium production and treatment, clearly has a lower emissions profile than the fossil fuel equivalent. The nuclear industry is highly likely to form part of the long term global solution to climate change. However, deep concerns remain over the environmental and social impacts of uranium transport, usage and waste storage and it is therefore excluded.
- **Agri-Businesses** are included in many measures of environmental performance due to their clear interaction with the environment. Yet this interaction is not always a positive one for the environment and the communities involved. In our definition of cleantech, we include only include companies that provide products and services to improve agriculture’s impact on the environment through, for instance, the use of water and energy saving technologies, and do not include the businesses that merely purchase these technologies.

Drivers of Growth

Much has been written on why investing in cleantech should derive superior long term investment returns¹. There have however also been discussions that the sector is just a

‘green bubble’ⁱⁱ. The growth of this sector is however underpinned by four key and strong macro-economic drivers that will ensure its longevity.

- There are many tangible assets being constructed to provide core services such as power, water, waste and recycling.
- The demand for these core services and for reduced impacts on the natural environment is growing due to both population growth and increasing wealth.
- As the world continues to use and deplete its natural resources there is increasing pressure on communities to adopt cleantech solutions to increase efficiency and decrease waste.
- There is the recognition of climate change and consequent regulatory regimes. This is a separate driver from those above and, whilst it will result in additional growth in some cleantech sub-sectors, it does not underpin the cleantech sector as a whole.

On a more immediate level, revenues for cleantech companies will grow from increasing demand from industrial companies. This demand is being driven by two issues:

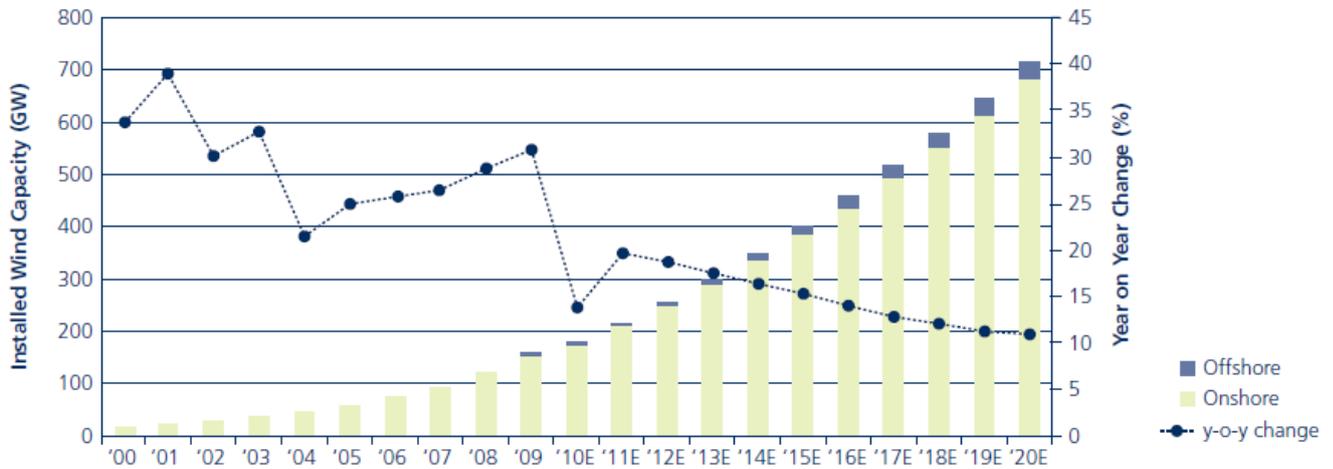
- Larger companies are facing increasing regulatory pressures to report on and reduce their environmental impacts. This not only includes emissions reporting but there are a multitude of other environmental regulations regarding air quality, effluent standards, impact on native vegetation and reduced water availability that are driving companies to seek more resource efficient and less polluting technical solutions.
- Companies are also starting to face supply chain pressures to both report on the environmental impacts of their operations and strive to reduce this footprint. Companies such as Walmart and Tesco are leading the way in this. In Australia, Reputex is now analysing and reporting on the supply chain emissions of the largest listed companies and this will increase this focus.

Cleantech Today

Cleantech solutions being deployed today include both obvious technologies such as wind power and the not so obvious technologies such as nanotechnology enabled materials, coatings and sensors. Some examples are described below under their sub-sector headings:

- **Renewable Energy** – large scale wind energy is the biggest current winner in terms of renewable energy technologies being deployed. As shown in the chart below, the SAM Group have forecast that global installed wind capacity will continue to grow

strongly through to 2020, increasing from the 2009 figure of 160 GW to over 700 GW. The majority of this will be installed onshore.



Rooftop solar and utility scale solar installation are also growing strongly driven by regulatory regimes in many developed countries.

- **Energy Efficiency** – there has been some focus on energy efficiency, but considering the numerous reports demonstrating the high Internal Rates of Return from investing in products and services that reduce energy consumption, it has to date not been a focus area. It appears likely that this is about to change with a change in focus by governments, Australia included, away from emissions trading and towards energy efficiency as the primary means of reducing total carbon emissions. Technologies such as building management systems, smart lighting, improved insulation products, variable speed motors and pumps and improved monitoring and control systems are all starting to gain momentum.
- **Biomaterials** – the evolution of biomaterials is only at a very early stage, but there are some products already in use. Biodegradable plastic that can be used in packaging and even biodegradable nappies are all currently available. In Australia, these are produced by Goody Environment and EcoQuest respectively.
- **Distributed Energy** – Again, distributed energy is probably only at the start of its evolution with distributed solar panels and small wind turbines supplemented with district power, heating and cooling systems (trigeneration), the introduction of household level fuel cell technologies (Ceramic Fuel Cells) and low grade geothermal systems (GeoExchange) becoming more widespread.

- **Distributed Water Systems** – As water pricing starts to increase in developed countries and water scarcity becomes a more significant issue in the growing populations of many developing countries, distributed water systems are starting to emerge. These range from technologies to harvest, store and reuse stormwater through the use of reed beds and aquifers (City of Salisbury) through to small scale systems that evaporate the humidity in the air to provide drinking water through solar power (F-Cubed).
- **Transport Technologies** – Before the recent financial crisis, the transition of vehicle fleets from internal combustion engines to electric motors was confidently predicted to be at least ten years away. The rate of transition has however made a step change with numerous Electric Vehicle (EV) models scheduled to be commercially available on a large scale from this year. Models such as the Mitsubishi Miev, the Nissan Leaf and the Tesla Roadster has redefined what an EV can be and it now appears as though EVs, along with their recharging infrastructure, will be a common feature in the built environment of the near future.

Cleantech Tomorrow

There are many clean technologies being developed around world and it is often difficult to make any forecasts on what will be the ‘winners’ of the future and which technologies, even if they do manage to get commercialized, will only have a short lifespan of viable utilisation.

Australian CleanTech has recently released a report titled Prosperous Sustainability: Technology Forecasts to 2050 that forecasts how global clean technologies may mature over the next 40 years. The aim of the report is to help provide investors and governments with a tool to picking long term winners for their regions.

The key questions that keep being asked by governments and investors is which technologies will be the long term winners that will provide both the greatest economic development opportunities and consequently the greatest investment returns. The key findings of the report are:

- **Rooftop Solar Panels** will not be installed after 2020 as Building Integrated Photovoltaics (BIPV) become standard installations for roofing and window materials.
- **Scale Wind Turbines** will start to be replaced by improved designs over the next five years. The last of the large scale wind turbines will be installed around 2030 as other technologies, such as utility scale solar and geothermal become cheaper in most regions.

- **Utility-Scale Solar** will have a long gestation but will continue to grow becoming widespread and peaking in installations in the late 2020s.
- **Wave and Tidal Power** will become viable at utility scale in the 2020s in niche locations but will eventually be phased out as cheaper alternatives emerge.
- **Electric Vehicles** will grow very quickly over the next few years along with the associated recharging infrastructure. It will continue to grow strongly through to the 2030s.
- **Energy Efficiency and Green Building Materials** and products will also grow strongly over the next few years and continue on this growth trajectory for many years to come.
- **Smart Grid** technologies will only grow slowly over the next 10 years due to the regulatory structures surrounding the utilities that must install them. Once these structures are effectively altered however, there will be significant growth worldwide.
- **Water Technologies** that create drinking water and help to reuse wastewater and stormwater for fit-for-purpose uses will continue to grow strongly throughout the forecast period. Technologies associated with reducing the energy use of desalination will grow particularly strongly.
- **Waste and Recycling Technologies** that recover 'waste' and turn into valuable resources that can be used again will also have strong steady growth driven by a reduction in raw resources leading to increasing resource pricing.

Whilst these predictions are not precise and will not provide the exact technology to back or company to invest in, by providing this environmental scan, the context for both political and investment decisions is provided and there are improved chances of success.

Cleantech in Australia

Internationally, the growth of the cleantech sector over the last four years has been meteoric. This growth is being driven in Europe by regulatory measures and the EU Emissions Trading Scheme and in the United States by the voracious appetite of the venture capital industry, combined with Government stimulus spending. In China the massive 'green stimulus' package is being complemented with far reaching regulatory measures. Other countries, such as Korea, see a great economic opportunity to leapfrog other developed countries through securing a leading position in cleantech.

Australia appears to be lagging on all of these fronts. The government stimulus is fragmented and small, the regulatory measures are providing only limited assistance and the venture capital industry is under-funded.

Yet Australian research and innovation is producing some of the world's leading technologies which are 'at the edge' of progress. Australian technologies leading the world include Dyesol, with its solar dye technology, CMA Corp with its zinc recycling technology and Carnegie with its wave technology. All of these have the potential to change the way the global built environment works and all have originated in Australia.

Cleantech also however encompasses some mainstream type businesses. Water, waste, photovoltaic and wind are the sectors that are tipped to grow most in Australia in the next two years. These are being driven by increasing regulations on water quality, recycling and renewable energy uptake.

In my work at Australian CleanTech, we work with technology companies, investors and governments in an attempt to drive the greatest benefits for all parties. We have worked with many technologies including the following:

- An environmentally friendly chemical vapour deposition technology that uses less energy and less toxic chemicals in the production of light emitting diodes (LEDs) whilst at the same time reducing costs. This technology, being developed by BluGlass, has now found a new application in the production of very high efficiency (>50%) photovoltaic cells that will potentially change the economics of global concentrating solar installations.
- A nanotechnology enabled selective enzyme biosensor that produces real time, highly sensitive results for nutrient monitoring. The CleanFutures AquaSens technology offers greater management control for nitrates and phosphates in water and for sulfites in wine.
- Dye-based solar cells (DSC) using an electrolyte, a layer of titania and ruthenium dye sandwiched between glass to produce flexible photovoltaic films. Dyesol has developed the technology and is working with global roofing and window manufacturers to create economic building integrated solar solutions.
- A technology for recycling polypropylene (PP) back into pellets that can be used in the manufacture of new PP products of the same quality and at a reduced cost. Novarise is currently China's biggest PP recycler and is starting to roll this technology out globally. The company recently listed on the Australian Securities Exchange.

Many other companies and technologies are innovating through utilising innovative business models including community finance and energy service company models. Often, the greatest success stories involve combining technology innovation with business model innovation to change the way consumers behave and how products are used.

A Cleantech Vision

The potential benefits to society of the spread of cleantech are far more than just reduced environmental damage. Through adopting technologies that reduce energy, water and resource usage, societies will increase their productivity, their global competitiveness and drive local economic development and employment.

This applies not only to the starting of new companies with new technologies, but also to increasing the resilience of existing industry to more effectively compete in the future.

In the collection of essays, *Opportunities Beyond Carbon*ⁱⁱⁱ, the concept of the transition to a more sustainable world presenting opportunities to also find solutions to other societal problems is explored. For instance, by improving town planning and building design and utilising cleantech solutions, emissions and resource use can be reduced. This can also lead to more integrated communities and, ultimately, happier, more connected residents. Writing in the *Environmental Leader*, this thought is further developed by Mark Johnson^{iv}, who suggests that it requires a wider level of systems thinking rather than just the application of new technologies into existing systems.

The ultimate goal of cleantech is to integrate it into everything we do, and, in the words of Vinod Khosla (one of the world's leading cleantech venture investors), to become 'maintech'.^v The category will then not be something special: it will just be the way things are done. This is one of the reasons that investing in the sector has merit. Those technologies that do become 'maintech' will generate extremely healthy returns.

Cleantech is indeed the word of the moment and will continue to be for some time to come. Australia has the ability to contribute significantly to the global cleantech sector and there are many potential long term benefits from becoming a cleantech innovation hub. These benefits derive from the fact that cleantech encompasses innovation that delivers a built environment that will create healthier and happier communities. Cleantech innovation can also produce a balanced economy that will help transition Australia into a sustainable future.

John O'Brien is Managing Director of Australian CleanTech, a research and broking firm that provides advice to cleantech companies and financial institutions. He has published the book, 'Opportunities Beyond Carbon' and the Australian Cleantech Review.

ⁱ Aston A (18 December 2008) *Investing in Cleantech Companies*, *Bloomberg Businessweek*, http://www.businessweek.com/magazine/content/08_52/b4114070599591.htm

ⁱⁱ Nordhaus T & Shellenberger M (20 May 2009) *The Green Bubble: Why Environmentalism Keeps Imploding*, *The New Republic*, <http://www.tnr.com/article/the-green-bubble>

ⁱⁱⁱ O'Brien J (editor) (2009), *Opportunities Beyond Carbon: Looking Forward to a Sustainable World*, Melbourne University Press.

^{iv} Johnson M (1 February 2010), *Why Systems Thinking, Rather Than New Technologies, Will Jump-Start the Clean-Tech Economy*, *Environmental Leader*, <http://www.environmentalleader.com/2010/02/01/why-systems-thinking-rather-than-new-technologies-will-jump-start-the-clean-tech-economy/>

^v Khosla V (2008), *It's about Main Tech, not Clean Tech*, <http://www.zdnet.com/videos/green/vinod-khosla-its-about-main-tech-not-clean-tech/222297>