ASSESSING CLIMATE CHANGE RISKS AND OPPORTUNITIES FOR INVESTORS

Industrials, Manufacturing and Materials Sector

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Industrials, Manufacturing and Materials[1] Sector

Introduction

The industrials, manufacturing and materials sector (hereafter 'manufacturing') constitutes over 30% of ASX 300 listed companies. In 2010-2011, the sector contributed $111.1 billion to Australia's GDP[2], accounted for 34% of total exports[3] and directly employed 980,000 workers.[4] In recent times, many companies in this sector have experienced significant pressures on profit margins due to international competition, rising input costs (energy, water and materials) and an Australian dollar at historic levels. Extreme weather events and drought pose additional risks to investors in these companies through damage to assets and/or negative impacts on operations and supply chains. Climate change is forecast, over time, to further increase the exposure of this sector to these risks. Concurrently, many opportunities exist to reduce risk exposure and operational costs through investment in energy efficiency and to exploit new sources of revenue through designing and manufacturing new materials and products to enable climate change adaptation and mitigation across the economy.

Purpose

This guide provides information to help investors assess and integrate climate risk and opportunity in the manufacturing sector into investment analysis.

How to use this guide

Identify the risk factors: Recognise key climate change, energy and carbon risks faced now by investors in the manufacturing sector in Australia.

(Table 1 and Table 2 provide a checklist of issues for investors)

Identify how risks will increase: Unmitigated climate change will increase risks related to weather, energy cost and carbon. Increasing risks are explained.

Identify the adaptation strategies and mitigation measures: The most cost effective measures companies can take to mitigate energy costs and carbon risks (reduce exposure) and adapt to physical risks (to build resilience for climate changes which can no longer be avoided) are then described based on observations of leading practices.

Assess materiality: Not all climate change risks affect all sectors equally. Tables identifying risks, adaptation strategies and mitigation measures in this guide include the most significant issues for the manufacturing sector.

Integrate the information into investment processes: The diagram below indicates how investors can integrate the information in this guide into investment practices.

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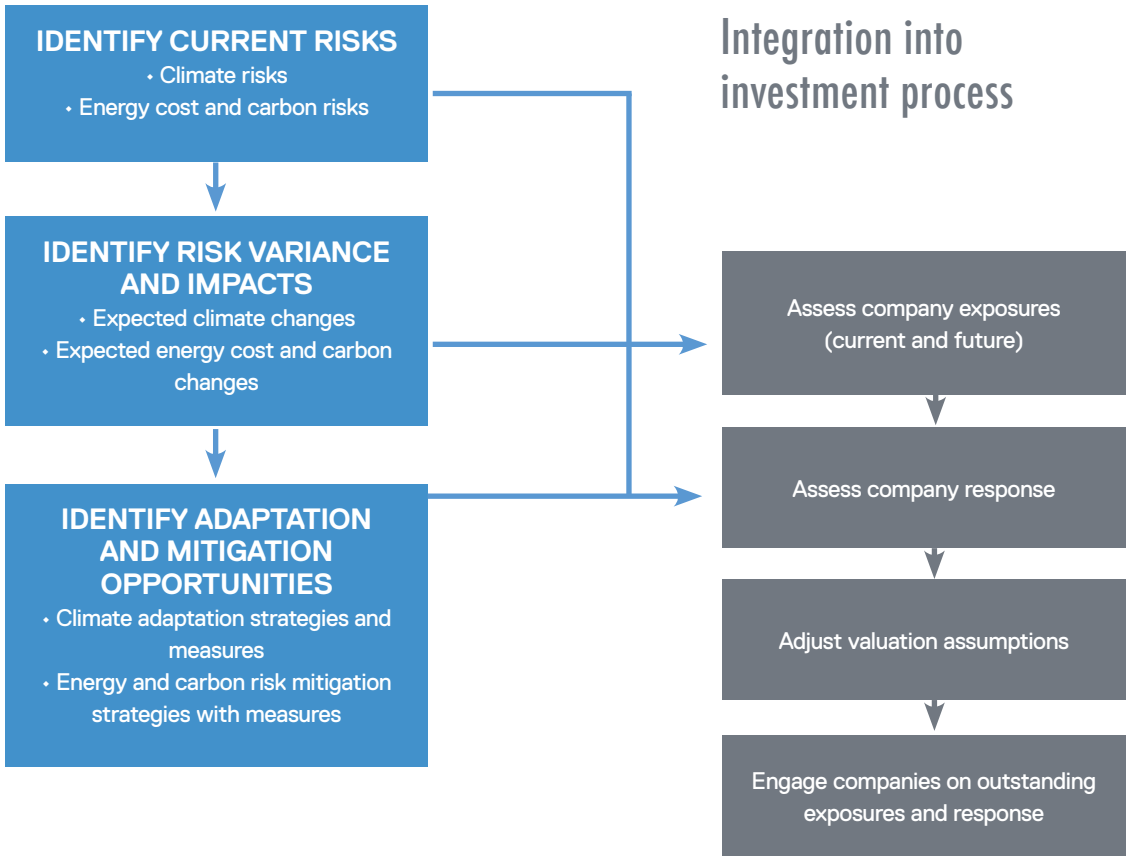

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SUMMARY OF CLIMATE RISK AND OPPORTUNITY IN THE MANUFACTURING SECTOR

Climate related risks

The World Economic Forum *Global Risks 2013* identified rising greenhouse gas emissions and failure to adapt to climate change as the two top risks most likely to materialise within a decade.[5] The failure to adapt to climate change was identified as the most systemically critical risk.[6] This is especially relevant for manufacturing, which is a capital intensive sector with many long life fixed assets, long supply chains, and significant water requirements to enable operations. Recent extreme weather events in Australia show how investor risk exposure is greater than previously thought. This is illustrated by the following examples:

Hailstorms	Hailstorms damaged most of the Ford vehicles at their Melbourne Broadmeadows plant on Christmas Day 2011. This contributed to the worst ever sales month for Ford in Australia for over half a century in January 2012 due to the inability to supply dealers.[7]
Flooding	The Queensland 2011 flood led to many manufacturing plants along the Brisbane River and in Ipswich being flooded, including the Dulux main paint manufacturing plant[8] and Australian Pharmaceutical Industries distribution, manufacturing centres and stores in Ipswich.[9]
Drought and higher electricity prices	The effect of the 2005-2009 Australian drought was to increase the cost of water to coal electricity generators who passed this on as increased electricity costs. This resulted in a doubling of the wholesale price of electricity from $30 to $60 per megawatt-hour in some parts of Australia.[10]
Bushfires and electricity disruptions	Approximately 30% of Australian manufacturing is based in Victoria. The January 2007 Victorian bushfire disabled the key NSW-Victoria electricity transmission line, reducing Victoria's electricity supply by a third, costing the Victorian economy an estimated $500 million.[11]
Extreme weather	Food and beverage manufacturers, which are dependent on raw materials from agricultural supply chains, are exposed to risks for higher input prices due to reduced supply of input materials from more extreme drought and extreme weather events. See Table 3 below for case studies.

Climate change risks, forecast change, potential impacts and adaptation strategies

The probability of these risks resulting in material financial impacts to manufacturing companies will increase with climate change over the coming decades. The many adaptation strategies open to companies summarised in Table 1 are described in further detail below in Table 6. The Australian climate change projections in Table 1 are based on the CSIRO and BOM State of the Climate annual reports[12] which, in turn, are based on international and Australian peer reviewed climate change research. This research uses a variety of climate models and scenarios based on global warming estimates from the IPCC Fourth Assessment Report. The projections will be updated from the IPCC Fifth Assessment Report in the 2014 State of the Climate report.

Table 1: Climate change risks, forecast change, potential impacts and adaptation strategies

	FORECAST CHANGE	IMPACTS	SAMPLE ADAPTION STRATEGIES
MORE INTENSE CYCLONES - FLOODING	+ 60% by 2030 (in cyclone intensity) [13] + 140% by 2070 (in cyclone intensity)[14]	Flood damage to assets Operations disrupted Supply chains disrupted Increased insurance costs	FOR CYCLONES AND HAILSTORMS Secure facilities' roofs Use appropriate roof materials Protect windows Weatherise facilities to ensure no gaps FOR FLOODING Employ storm water management and flood prevention strategies Pumping equipment and backup generators Insurance Engage with government and other stakeholders FOR SEA LEVEL RISES Planned retreat for existing assets below 1.5-2m above sea level
MORE FREQUENT HAILSTORMS - FLOODING	Hailstorms in the Sydney basin have occurred approximately once every 5-8 years over the last few decades. Modeling predicts a further +20% increase in frequency by 2050[15]		
MORE INTENSE RAINFALL EVENTS	Despite overall decreases in rainfall (see below), rainfall events will become more intense creating a greater risk of flooding		
STORM SURGES COMBINED WITH SEA LEVEL RISES	18cm to 79cm sea level rise combined with storm surge by 2100[16]		
REDUCED WATER AVAILABILITY	2030 % / 2050 % / 2070 % North: -10 to +5 / -20 to +10 / -30 to +20 South: -10 to 0 / -20 to 0 / -30 to +5 **Number of months in drought by 2070** South Western Australia +80% Eastern Australia +40%	Increase in water prices and costs Potential investment in onsite rainwater harvesting infrastructure Higher electricity costs	Improve water efficiency Rainwater and stormwater harvesting and reuse Purchase recycled water from water utilities Invest in co-generation technologies
HIGHER AVERAGE TEMPERATURES	0.1 to 1.5°C by 2020 0.3 to 4.0°C by 2050 0.4 to 8.0°C by 2080[17]	Higher energy and water costs (ie. higher air-conditioning and refrigeration loads)	Improved building 'thermal' envelope Cool roofs Reduce waste heat losses Recovery waste heat Energy efficient air-conditioning Solar powered air-conditioning
MORE DAYS OVER 35°C (Northern Australia)	7 to 11 days per annum in 2000 69 days per annum by 2030 308 days per annum by 2070		
HIGHER RISK OF BUSHFIRES	Days with very high and extreme Forest Fire Danger Index (FFDI) ratings[18] 4 to 25% by 2020 15 to 70% by 2050	Electricity transmission line shut downs to reduce bushfire risk Electricity brownouts from demand exceeding supply	Improve onsite energy efficiency Reduce waste heat losses Invest in onsite co-generation and renewable energy technologies Invest in onsite backup generators

*Adaptation strategies listed in this table are a sample of risk management measures available to companies.

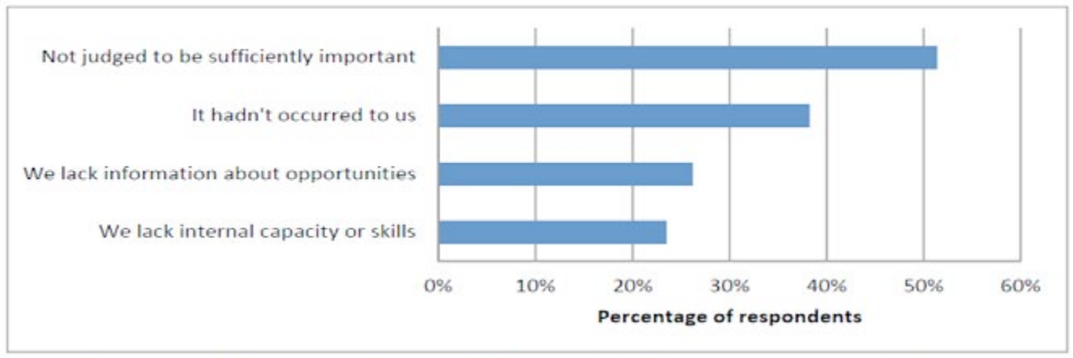
Climate change adaptation – opportunities to create shareholder value - Manufacturing has a critical role to play in developing and producing technologies and products to help adapt to climate change. Many Australian manufacturers are already producing technologies and products for the rapidly growing climate change adaptation product and services market worth billions per annum. This market includes many diverse products such as more resilient building and construction materials[19], sustainable water management products[20], emergency communication technologies as well as flood prevention/stormwater management technologies. Analysts should note to what extent Australian manufacturers have developed, or are developing, product lines in this area and what potential they have to increase revenue.

Beyond Compliance – Leading manufacturers are using climate change adaptation strategies which go beyond compliance to reduce their exposure to the risks of climate change while enhancing revenue with new climate change adaptation product lines.

Energy costs, carbon risks, adaptation and mitigation opportunities

Energy contributes significantly to operational costs in this sector, so investment in energy efficiency can secure material savings. Capturing and reusing heat generated in the production process, equipment upgrades and process innovation, are examples of how a higher level of energy efficiency can combat energy cost increases and improve market competitiveness. Latest studies indicate a 10% cut in energy costs can result from improved energy efficiency in existing plants with greater levels of efficiency possible in new plants. Historical under-investment in energy efficiency has occurred due to competition for internal capital, tough internal ROI requirements of less than one year, and a lack of reliable information or skills to identify and implement such profitable mitigation projects.

Figure 1: Reasons why business did not actively manage electricity use **(Source: AIG, 2012[21])**



Manufacturing also has the potential to create new revenue streams and significant value to shareholders from innovating low carbon products for climate change mitigation. For instance, Siemens recorded a record US$38 billion net profit result from their global Environmental Portfolio in 2010. General Electric's Ecomagination initiative has resulted, from 2005, in US$130 billion worth of revenue from more energy efficient low carbon products, US$25 billion in 2012 alone.[22] GE Australia's Ecomagination activity stream is the most profitable activity area of its business. Many Australian based manufacturers are also strategically positioning for a low carbon future, such as:

- CSR Limited, which is Australia's largest insulation and low emissivity/double glazed window glass manufacturer. CSR recently used these materials to demonstrate how they could build an 8 star energy efficient house for a similar price as a traditionally built and de-signed home.[23]

- Boral, which has innovated a new construction cement which achieves 40% reductions in carbon emissions without affecting the strength of the cement or the speed at which it sets.[24]

- Toyota, which has pioneered hybrid car making in Australia. Local hybrid car sales have already eclipsed imported Toyota Prius sales in Australia.

- Visy Industries, which has become the world's largest private recycling company by investing in recycling plants which manufacture low carbon materials while also reducing emissions from stopping waste going to landfill.

Other risks and opportunities are summarised on the next page.

RISKS AND OPPORTUNITIES	
Rising electricity and water prices	Electricity prices have risen significantly in Australia largely due to significant investment in energy supply infrastructure. Without policy reform to improve demand management and energy efficiency this is likely to continue. Australian retail electricity and water prices by some estimates will rise by at least 100 per cent from 2005 levels by 2015.[25] Natural gas prices increased from $2.50 to around $8.00 per gigajoule (GJ), with some recent contracts reported to be up to $12/GJ in Western Australia. In eastern Australia, the price increased from about $3.50 to $6/GJ in the last few years, with an expectation of prices as high as $9.00.[26] Energy costs can reduce by at least 10-20% through energy efficiency opportunities for most ASX 300 companies.
Direct Action policy reforms	The Federal Coalition Government's Direct Action policy is expected to assign an energy /greenhouse gas intensity baseline from the historical emissions of either company or industry sector (still to be determined). If a company's emissions intensity falls below its assigned baseline it can sell this abatement to the government. If a company's emissions exceed a historical average a financial penalty will apply to companies currently reporting their emissions profile under the National Greenhouse and Energy Reporting (NGER) scheme subject to consultation.[27]
Expanding MEPS to industrial equipment	To date, the COAG Equipment Energy Efficiency (E3) program has focused on domestic appliances and largely ignored industrial and manufacturing equipment. If minimum energy efficiency performance standards (MEPS) were applied to industrial and manufacturing equipment, it would save at least $1.5 billion per annum in industry energy costs and annual greenhouse abatement of up to 2.8 Mt CO^2-e.[28]
National Electricity Market (NEM) reform	Manufacturing could earn an additional billion plus dollars per annum by selling back electricity to the NEM during peak demand periods when electricity spot prices are highest. This would represent a far more economically efficient way to meet peak electricity demand than current approaches which see 25% of all electricity supply and grid infrastructure in NSW built to service peak electricity demand, which accounts for less than 1% of total annual electricity demand.
Energy efficiency financing options	Numerous financing options enable manufacturers to reduce exposure to rising energy and carbon costs through investments in energy efficient equipment without incurring significant upfront costs. Analysts should ask if companies are taking advantage of these innovative financial strategies.
Increasing energy efficiency product standards	Energy consumed by manufactured products – vehicles, appliances, industrial and cooking equipment, building materials – is a major source of greenhouse gas emissions. Improving their energy efficiency is a key objective for most governments internationally[29] including Australia. If manufacturers fail to improve the energy efficiency of their products they will lose market share. Many manufactured appliances and products use 90%+ energy during the lifetime of their use rather than during their manufacture**.** Manufacturers can build customer loyalty by designing appliances and products to use significantly less energy and save their customers money.[30]
Disruptive Technologies	Sir Nicholas Stern has warned that a transition to a low carbon future will result in "creative destruction" throughout the economy. Low carbon disruptive technologies are already emerging with the potential to transform manufacturing and leave laggards in their wake. For instance, 'additive' manufacturing using 3D printing uses up to 90%[31] less materials to produce products leading to significant energy and water savings over the product life cycle. Remanufacturing parts through advanced additive manufacturing and surface treatment processes can also return end-of-life products to as-new condition[32], achieving 75-98% energy savings compared to making new parts.[33] This is just one of numerous potentially disruptive manufacturing technologies emerging globally.[34]

Energy price and carbon policy related risks and opportunities are summarised in Table 2 with relevant mitigation strategies for investors to discuss with companies.

Table 2: Energy and carbon policy risks and opportunities, forecast change and sample mitigation strategies

	FORECAST CHANGE	MITIGATION STRATEGIES
HIGHER ENERGY COSTS	Electricity prices increased four times the rate of inflation over the last five years but latest forecasts see more modest 3-4% per annum increases in the next two years Western Australia – Natural gas prices have more than tripled. Eastern Australia – Natural gas prices have almost doubled in the last few years, with an expectation of further increases as high as 50%[35]	Energy Efficiency and Demand Management Improve industrial process efficiency Improve efficiency of common technologies eg motors Waste loss minimization Invest in waste heat recovery and co-generation Invest in cost effective onsite renewable energy options
GOVERNMENT ENERGY EFFICIENCY (EE) DIRECT ACTION PAYMENTS	Direct Action Emission Reduction Fund will invest an annual average of around $1.55 billion in direct CO^2-e emissions reduction activities for business through to 2020	
EXPANSION OF MEPS TO INDUSTIAL EQUIPMENT	+ $1.5 billion per annum in reduced energy costs	
NATIONAL ELECTRICITY MARKET REFORM	+ $1 billion revenue through selling electricity back to the grid at peak spot prices to assist Australia meet peak electricity demand	
ENERGY EFFICIENCY FINANCING OPTIONS	Relatively new to Australia, these have been used for over 20 years in North America and Europe, so potential market growth in Australia is significant.	Leasing energy efficient lighting and equipment On-bill financing with manufacturer's electricity provider Energy performance contracts (EPCs)
GROWTH IN LOW CARBON MANUFACTURED PRODUCT MARKETS	Energy efficient technologies markets to grow from $200 billion (2010) to $312 billion (2015)[36] Renewable energy markets to grow 1,840 terawatt hours (TWh) (2011-2017), 60% above 1,160 TWh growth (2005-2011)[37]	Energy efficient product design Renewable energy systems and components Rechargeable battery technologies Energy efficient vehicles Vehicle to grid technologies Smart Grid technologies

ANALYSIS OF THE CLIMATE CHANGE RISKS

The Australian manufacturing sector currently faces significant international competition. Pressure on profit margins in the sector has been compounded by historically high input costs (energy, water and materials) (see Figure 2) and the above average value of the Australian dollar.[38]

Higher input costs: the costs of inputs for manufacturers have risen to such an extent that input commodity price rises in the last decade wiped out the previous 100 years of commodity price reductions[39]. Since 2000, for instance, global metal prices have risen by 176 per cent, rubber prices by 350 per cent, and food prices by over 100 per cent.[40]

Figure 2: Commodity prices have increased sharply since 2000, erasing all the declines of the 20th century **(Source: McKinsey, 2011[41])**

McKinsey has evidenced this last decade's historic price rise of inputs for manufacturers as driven by three interlocking factors: (i) increasing demand due to the rise of the middle class in Asia (ii) the law of diminishing returns and (iii) the negative impacts of extreme weather events, such as extreme drought, leading to a nexus of climate, water, energy, resources and food production (Figure 3). Due to the law of diminishing returns, more energy, water and resource inputs are often needed to extract the same quantity of a particular natural resource. For instance, as the Mining and Minerals Processing report in this series illustrated, the energy and water input intensity of mining and mineral processing is rising as mineral ore grades continue, on average, to decline. In addition, the energy intensity of delivering water, and the water intensity of delivering energy has never been higher. According to the IEA, current energy policies will result in the volume of water consumed for global energy production to double by 2035.

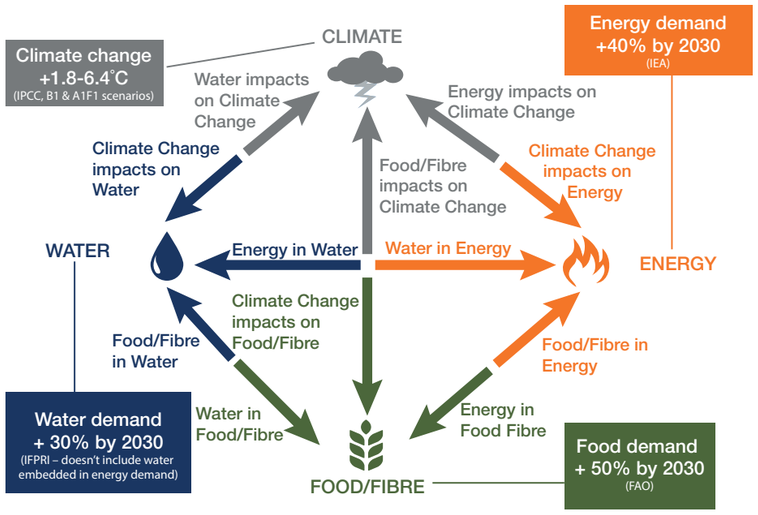
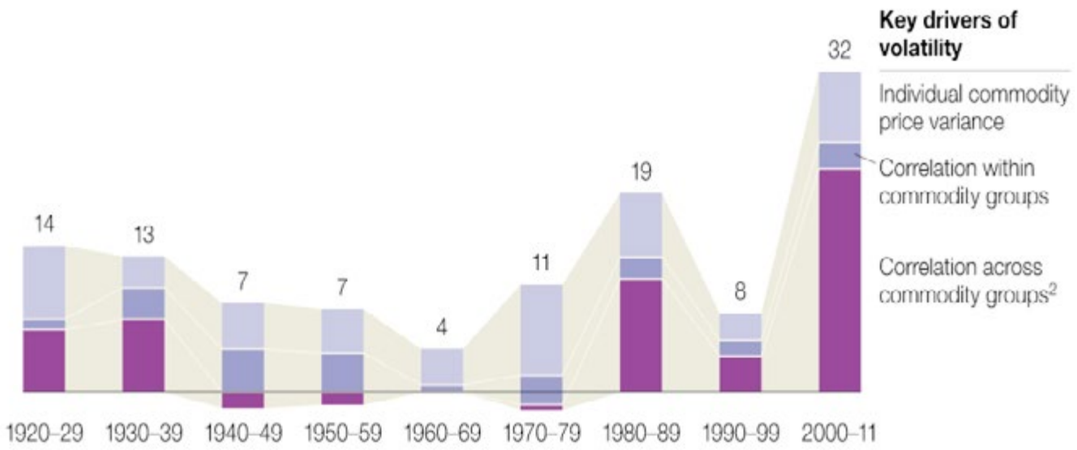


Figure 3: The climate change, energy, water and food production nexus **(Source: WBCSD, 2012[42])**

This strengthening nexus is also key to explaining the historic increase in volatility of global commodity prices over the last decade. Directly impacting manufacturing inputs costs, commodity price volatility in the last decade is higher than at any other time in the last one hundred years (Figure 4 below). These strong nexus linkages (Figure 3) result in shortages and price changes in one commodity resource rapidly impacting on other commodity prices.[43] Studies show the correlation between critical commodities is now higher than at any point over the past century (Figure 4). This volatility can be at least as disruptive, or more so, than rising price trends.

Figure 4: Relative scale and drivers of commodity volatility by decade from 1920 to 2011 **(Source: McKinsey Global Institute, 2011[44])**



- The last decade in Australia has seen substantial prices rises and volatility resulting from this nexus, as illustrated by:
- **Drought and increased water scarcity** combined with **poor water infrastructure choices** (over-investment in desalination plants) have more than doubled water and trade waste costs to business over the last decade
- **Drought and extreme weather events** have resulted in reduced supply and subsequent higher prices of raw materials from agricultural supply chains, to the textiles (fibre), food and beverage manufacturing sub-sectors (see Table 3)
- **Drought and bushfires disrupting electricity production and distribution have caused electricity price rises** as explained by the Australian Industry Group, "*The ability of (hydro and coal fired power generators) to supply the market has also been squeezed, largely due to drought and extreme weather. Reduced inflows and water allocations diminished the available capacity from hydro generators and from some coal generators, which require large amounts of water for cooling. During bushfires and extreme heat events, major interconnectors and transmission lines have become congested or inoperable, leading to price spikes in markets temporarily isolated from some cheap generation capacity.*"[45]
- **Higher temperatures and heat waves have led to increased costs:** from air-conditioning and commercial refrigeration having to work harder, from equipment overheating, from accelerated deterioration of assets, and from electrical equipment running less efficiently.

This strengthening nexus means an increasing risk to be managed by Australian manufacturers as global commodity values are affected by both volatility and price spikes.

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Table 3: Price spikes from drought and other extreme weather events in Australia 2001-2010

CATEGORY	PRICE INCREASES	EFFECT OF SEVERE CLIMATE CHANGE (MORE THAN 2°C GLOBAL WARMING)
VEGETABLES	2005–07: +33%	Locally produced products such as these are vulnerable to price spikes during local droughts. Price shocks similar to those experienced in the previous Australian drought may occur every two to four years, instead of once per decade as has been the historical norm. If some producers are unable to adjust to severe changes, permanently elevated price levels could result.
FRUIT	2005–07: +43% Bananas 2005-06: +300%	
HONEY	2002-03: +100%	
BREAD	2005–07: +17%	Bread prices depend in part on global wheat prices. Global wheat yields are likely to decline with temperature increases of more than 3ºC[46], thus increasing global prices and permanently elevating bread prices.
EGGS	2005–07: +17%	For eggs, dairy and many meat products, water and grain for feed are important inputs. As with bread, increases of more than 3ºC would continue to drive up global grain prices, while climate change is likely to decrease water supplies. Dairy dependent on irrigated pasture is vulnerable to water scarcity, while native pasture capacity will decline by up to 40% for temperature increases greater than 2ºC[47]. Severe climate change is likely to cause permanently elevated prices, with further shocks during drought.
MILK AND DAIRY PRODUCTS	2005–07: +11%	
MEAT AND SEAFOOD	2005–07: +4% Lamb 2000–03: +59% Beef 2000–03: +31%	
ALL FOOD PRODUCTS	2005-07: +12% 2002-03: +4.4%	
CPI	2005-07: +6% 2002-03: +2.7%	

(Source: Quiggin, J. *Drought, Climate Change and Food Prices in Australia*[48])

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Risk of significant financial losses from damage to facilities and disruption of operations

The manufacturing sector in Australia is exposed to risks from climate change due to the likelihood of more intense extreme weather and flooding events which can delay construction, damage assets, stop operations, interrupt supply chains and lead to price spikes. This can be illustrated by recent high profile extreme weather events:

- **Hailstorms** It is well known that hailstorms have caused billions in property damages, including manufacturing facilities, in Sydney, Perth, Melbourne, Canberra and Brisbane in the last decade. What is less well known is that hail can also destroy significant quantities of manufactured stock. Over 1000 Ford Falcon and Territory vehicles were damaged by the hailstorms that hit their Melbourne Broadmeadows plant on Christmas Day 2011 and could not be delivered to customers. This contributed to the worst ever sales month for Ford in Australia for over half a century in January 2012.[49] Due to climate change, more frequent (+20% increase in frequency by 2050) and intense hailstorms are predicted. To illustrate, Sydney has experienced six significant hailstorms in just over the last 20 years or so, a significant increase on the previous one hundred years.(See reference 59)

- **Storm surges combined with sea level rises** Climate change creates new risks for manufacturing such as increased flooding from storm surges combining with sea level rise over time. An estimated 3,700-6,200 industrial/manufacturing plants and sites will be vulnerable by 2100. Additionally, property owners of insured coastal manufacturing sites may lose billions of dollars, as while the value of coastal manufacturing sites may have some insured protection, the loss of land value is not insured against inundation or severe erosion (or the threat of inundation) so owners will not be compensated by insurance.

- **Intense flooding events** The last three years in Australia have shown how many manufacturing facilities are more vulnerable to serious disruption and profit loss from flooding than previously understood. For instance, the Queensland 2011 flood led to the closure of the main Dulux paint manufacturing plant at Rocklea in Brisbane's south[50]. and of Australian Pharmaceutical Industries distribution, manufacturing centres and stores in Ipswich.[51] The wetter conditions experienced in Australia in the last two years are consistent with scientists' knowledge and understanding of anthropogenic (human induced) climate change.

Australia's climate is significantly affected by the La Niña/El Niño oscillation in the Pacific Ocean. The El Niño oscillation brings drier drought conditions to Australia while La Niña brings higher rainfall events. The oscillation between these two cycles underpins why Australia has always been the land "of droughts and flooding rains." The latest climate science suggests it is highly likely this oscillation between drought and flood will become more extreme and intense, so when a long dry period of El Niño transitions into La Niña, rain is more likely to fall as heavy downpours than as extended drizzle. Warmer climates also enable more intense rainfall events as warmer atmospheres can hold more water vapour.

Climate change impacts

Having understood the likely risks from climate change, the next step for investors is to assess the potential impact on manufacturing companies. Table 4 provides an overview of in-house risk analysis by many leading manufacturing companies through their Carbon Disclosure Project reports from 2012. Investors can use this overview as an analytical checklist to help enable a rapid assessment of the risk exposure for a particular manufacturing company's assets and benchmark the company's awareness of its climate change related risks.

Table 4: Analysis of climate change risks and potential impacts

* Companies listed are a sample of those reporting through CDP their recognition of these risks. (Source: Smith, M. Stasinopoulos, P, 2013)

RISKS	IMPACTS	Manufacturing Companies* Reporting Climate Change Risk
DROUGHT	**Greater competition for water** - Greater competition for water due to scarcity in local communities, may have consequences for cost, reputation, and social licence to operate.	Coca-Cola Amatil, Fosters, Lion Nathan, Diageo, SABMiller
VARIABLE WEATHER, RAINFALL AND TEMPERATURE CHANGES	**Reduced production and input price spikes from supply chains:** - Reduced productivity due to variable weather and rainfall and prevalence of pests affects availability and increases costs of key inputs such as sugar cane, corn, beets, citrus, coffee, tea, produce, grains and milk. - Coking coal prices sky-rocketed post the 2011 Queensland floods, impacting steel manufacturers and other industries. Benchmark prices for hard coking coal soared to an unprecedented US$330/t Free On Board (FOB) and some spot deals may have settled even around US$400/t, close to 100% above pre-flood prices.[52] - The 2011 floods in Thailand impacted car parts for auto manufacturers in Australia.	Amcor, Visy Industries, Orica, Coca-Cola Amatil, Aquila Resources, Incitec Pivot, Innovia Films, OneSteel, SimsMM, Alumina, Boral, Electrolux, Alcoa, Ford
HIGH TEMPERATURES AND HEAT WAVES	**Increased energy, water and maintenance costs** - Increased run hours to maintain comfort conditions resulting in higher energy costs, reduced equipment lifetimes and higher maintenance costs. - Heat waves and higher temperatures lead to plant stress and can reduce crop yields leading potentially to higher costs for key ingredients for food and beverage manufacturers.	Orica, Coca-Cola Amatil, Electrolux, Alcoa,
SEA LEVEL RISES - RISKS OF FLOODING	**Flooding from sea level rises combined with storm surges**: - Climate change will make it much more likely long term for manufacturing and industrial sites to be negatively affected by flooding from sea level rises and storm surges. This is likely to affect an estimated 3,700 to 6,200 industrial sites around the country by 2100.	Orica, Coca-Cola Amatil, Boral, Alcoa

MORE INTENSE EXTREME WEATHER EVENTS - GENERAL	**Increased costs from manufacturing asset damage, loss of operations**
	- Increased extreme weather events and flooding can cause delays to operations as well as damage to manufacturing facilities and equipment through
	  - increased water and the moisture penetration
	  - increase ground and foundation movement
	  - degradation and failure of pipe structures.
	- Extreme weather events can cause damage to manufacturing sites, property and products, which increases the costs of maintenance, repair and replacement.
	- Extreme weather events can disrupt electricity services, delay supply chains of critical materials/ inputs, and increase insurance premiums.
	Higher insurance premiums
	- Since 2000, insured costs from extreme weather events have risen exponentially. Insurance payouts have been rising faster than CPI due to this.[53]
	- Insurance costs may rise still further because of the US$160 billion worth of damage in 2012 caused by natural disasters. Munich Re has estimated close to 16% of similar costs in the last few years are from Australia and New Zealand. This is being reviewed and could lead to rises in reinsurance costs for Australia.
		Amcor, Coca Cola, Innovia Films, SimsMM, Alumina, Boral, Electrolux, Alcoa (storms)

To conclude, the risks to manufacturing companies in Australia from unmitigated climate change are extensive. Experience shows many of these risks and their potential costs can be ameliorated through appropriate and cost effective adaptation and mitigation strategies, outlined below.

ANALYSIS OF CLIMATE CHANGE ADAPTATION OPPORTUNITIES TO ADDRESS CLIMATE RISKS

Increasingly manufacturing companies are going beyond compliance to adequately protect and adapt their assets, operations and supply chains to reduce risk exposure to drought/lack of water, extreme weather, floods and storm surges. There is a growing recognition how current regulatory frameworks and government standards are inadequate to prevent and protect company assets and operations from more intense extreme weather events and flooding. The manufacturing facility buildings are regulated principally by planning policies set by state and local governments and the national Building Code of Australia (BCA). Many of these regulations were developed decades ago with, at best, outdated consideration to climate change risk profiles.[54] New construction compliant with the current BCA has been assessed as 'likely to be reasonably adequate' only under 'low emission scenarios'. Buildings built to earlier standards may be vulnerable to climate impacts, as are BCA-compliant buildings under higher emission scenarios.[55]

State governments and local councils also differ considerably in their approach to climate change risk for new and existing manufacturing/ industry precincts, ranging from no consideration to detailed prescriptions. Australia lacks a cohesive national coastal planning framework. Victoria's Coastal Climate Change Advisory Committee has warned 'strategic planning as currently undertaken...is unlikely to be effective in driving the significant planning needed for climate change responses', due to a lack of agency integration, but also a 'lack of sense of priority across state and within local Government areas'.[56]

To address this, a national climate change adaptation framework draft has been released for comment(See Key Resources). A national climate change adaptation initiative is needed because a proactive approach to designing new (and retrofitting old) buildings and infrastructure to be resilient to risks from climate change will deliver significant financial benefits and cost savings over the longer term, including:

- reduced risks and liabilities from considering climate change in industrial park and manufacturing facility design
- higher future asset values due to lower ongoing operational costs
- lower repair and maintenance expenses, with a reduced need for retrofits
- minimised investment in high risk areas
- lower insurance premiums due to a reduced chance of damage to premises from climate change impacts
- decreased energy costs for assets that have been adapted to long-term temperature changes.

Numerous studies show an overwhelming cost benefit from climate change adaptation measures for this sector.[65] Climate change adaptation reduces financial risk because it is generally less expensive to increase resilience prior to an event than to recover after one. Also mechanisms to increase resilience tend to be more cost effectively implemented early (through planning, design, or policy) than through subsequent retrofit. Leading manufacturing companies are going beyond compliance to prevent damage, reduce long term operational and insurance costs and "drought proof" their businesses. Inghams Industries, featured in Table 6 below, has shown how investing in these measures has achieved a net lowering in water input unit costs, whilst providing a secure water supply to double production at their most water efficient plant. It also insured against the risk of losing access to adequate water to operate if the most recent drought had become still more severe. Another key reason for going beyond compliance is to achieve and maintain licence to operate. For instance, where paper mills, sugar mills or food and beverage processing plants operate in rural regions, they are often the largest single user of water and energy. The Visy Industries Tumut paper mill in NSW has shown to what extent manufacturing plants can reduce both energy and water consumption simultaneously, as its environmental footprint is negligible. The Visy Industries Tumut mill is virtually climate neutral. Total water usage is 80 per cent lower than the average water used by standard industry pulp and paper mills elsewhere in the world, entirely recycled, treated and returned to nearby farmland for agriculture. These world class environmental achievements were critical to enabling the Visy Industries Tumut Pulp mill to be the first paper mill built in Australia in over 20 years after community opposition stopped the Wesley Vale Pulp Mill in Tasmania in 1989.

Table 5: Climate change adaptation strategies

CLIMATE CHANGE RISKS	RISK MANAGEMENT/ CLIMATE CHANGE ADAPTATION OPTIONS	Manufacturing Companies implementing adaptation strategies (Sample)
HAILSTORMS	To reduce risks of damage to plant and manufactured products - **Optimise roof pitch:** Increasing roof pitches can dramatically improve hail resistance - **Protect windows:** Windows can be protected from gale force winds and flying debris by putting appropriate metal wire protective screens or shutters in place - **Use resilient roof materials:** There are a range options to consider in the choice of roof materials for new and existing buildings to make them more hail resistant [57] - **Ensure manufactured products are stored under safe roofs** in manufacturing plants or warehouses to avoid hailstorm and rain damage.	

DECLINE IN WATER AVAILABILITY	There are numerous ways to make manufacturing plants more independent of mains water supply, including:
	- **Water efficiency strategies which utilise**
	  - water efficient spray nozzles and spray guns
	  - clean in place strategies using sensor technologies
	  - steam traps and condensate return systems for boiler systems
	  - water efficient cooling tower systems and technologies[58]
	- **Onsite water harvesting and reuse strategies** which utilise
	  - **rainwater tanks**[59]
	  - **stormwater harvesting systems**
	  - **constructed wetlands**[60]
	- **Onsite water treatment and recycling plants**[61]
	- **Recycled water supplied by water utility**: using dual reticulation piping to ensure freshwater and recycled water can both be used.
		Visy Industries, Coca-Cola Amatil, Treasury Wine Estates, Boral, Electrolux, Alcoa, Ford, Fosters, Diageo Australia Limited, Cadbury Schweppes, Murray Goulburn Co-operative (Dairy), The Lion Nathan Group, Inghams Enterprises

HIGHER TEMPERATURES & MORE INTENSE HEATWAVES	**To reduce risks of higher energy and water costs and workforce heat stress:** - **Insulate medium to high temperature equipment** to reduce waste heat losses and improve workplace conditions for employees - **Improve the "thermal" building envelope** using better building insulation, high performance window glazing, external window shading, proper window coverings and natural ventilation - **Paint roofs "reflective white**" to reduce air-conditioning loads by as much as 20%.[62]	Electrolux, Alcoa
EXTREME WEATHER EVENTS	**Reduce production and input price spikes from supply chains** - **Diversify supply chains** and ensure suppliers are minimising vulnerability to extreme weather events - **Encourage suppliers to use water efficiently to reduce vulnerability to drought.** Assist agricultural based supply chains to better understand their water footprint and assist their transition to more water efficient practices[63] - **Be ready to source different inputs in case current suppliers operations are disrupted and prices spike for one commodity.** For instance, the steel industry in Australia in 2011 has experienced coking coal prices spike due to the floods of Queensland coal mines. Alternatives currently used by leading steel manufacturers around the world include hydrogen-rich fuels, old tyres and plastics.	Diversify global supply chains – eg. Toyota[64]. Water footprinting and working with supply chains – eg. Mars Australia, Fosters Group, National Foods, Nestle, Goodman Fielder, and Kelloggs. Diageo, Coca Cola Amatil, Alternative Reductants in Steel Making – eg. Arrium Limited
MORE INTENSE EXTREME WEATHER EVENTS- GENERAL	**Reduce risks of increased costs from industrial site damage and disruption of operations by** - Employing effective storm-water management strategies - Weatherproofing manufacturing plant buildings as quickly as possible - Ensuring pumping equipment can cope with worst case scenario flooding - Effecting insurance policies to cover physical plant damage, flood damage, business continuity and business disruption.	Coca-Cola Amatil, Electrolux, Amcor, Coca-Cola Amatil, Incitec Pivot, SimsMM, Alumina, Boral, Electrolux
HIGHER RISK OF BUSHFIRES	**Reduce risk of loss of electricity supply by investing in** - Onsite co-generation, trigeneration or renewable energy systems - Backup generators.	
STORM SURGES COMBINED WITH SEA LEVEL RISES	**Reduce risks of flooding, inundation and stranded assets** by - Reviewing or developing a sea level rise adaptation strategy for existing manufacturing sites - Ensuring new manufacturing sites are well above sea level.	Alcoa

Table 6: Sample of manufacturing businesses going beyond compliance – drought proofing

SECTORS	BEST OF SECTOR CASE STUDIES
Steel Manufacture	In the 1930s and 1940s, steel production typically consumed 200–300 tonnes of water per tonne of steel.[66] BlueScope Steel's Port Kembla steelworks now uses 0.9 tonnes of freshwater per tonne of steel. This steelworks is aiming to use entirely recycled water and seawater for all processes and thus be completely independent of freshwater within five years.[67]
Paper Manufacture	Since 1900, best practice in the amount of water used per kilogram of paper produced has improved from 500-1000 litres per kg to 1.5 litres per kg of paper produced.[68]
Pulp and Paper	Encore Tissue (Aust) Pty Ltd saved 166 megalitres of water over the 12 months to June 2011 by making a considerable investment in innovative new technology. Encore saved 50% of its potable water use, recycled waste-water in the tissue making process and achieved significant reductions in trade waste discharges.[69]
Cardboard Manufacture	At their Cartonboard Mill in Petrie, Amcor Australia has achieved annual savings of more than 1000 megalitres, via a 90% reduction in the use of drinking water in the manufacturing process, by using treated and recycled water.[70]
Food Manufacture- Poultry Processing	Ingham's Enterprises has achieve 20% water efficiency savings and has reduced mains water usage by 72% in their major Brisbane poultry processing plant through water treatment and recycling onsite. This has reduced freshwater demand by 545 megalitres per annum and the onsite recycled water treatment plant produces water for reuse cheaper than mains water, setting a new global benchmark.
Beverage Manufacturing	Diageo, a major international beverage manufacturer, has achieved 43% water saving at its Huntingwood site in Sydney. This amounts to an annual saving of 55.5 megalitres.[71]
Beer Manufacturing	Fosters Brewery at Yalata, Queensland[72] has achieved a 75% improvement in water efficiency since 1993. Breweries, on average, use about 6-8 litres of water per litre of product, but Fosters Brewery at Yalata only uses around 2 litres of water per litre of beer. [73]

Creating shareholder value –strategically positioning for climate change adaptation technology markets

Many Australian product manufacturers are already strategically positioning themselves for growth by producing climate change adaptation technologies and products to help business and households adapt to risks from climate change. Analysts should develop an understanding of what potential to increase shareholder value these technologies and products Australian manufacturers have developed, or are developing, to help adapt to:

- **Higher probability of more days over 35 degrees Celsius** – Australian manufacturers already produce a variety of manufactured products to better insulate commercial buildings, factories, and households from extreme hot weather. These manufactured products include advanced insulation products, double glazed windows, low-emissivity windows, energy efficient lighting (which emits less heat than incandescent globes) to name a few. There are also emerging opportunities to further develop low carbon forms of ventilation and air-conditioning.
- **Greater risks of extreme weather events** – Several Australian manufacturers already make products to reduce the risks of damage to buildings and infrastructure from extreme weather events.
- **Greater risks of variable water supply and water purity** - Many Australian manufacturers, spurred on by the recent drought, have innovated and developed many locally manufactured products/technologies to help achieve greater levels of water efficiency, water storage, treatment and recycling.[74] Some Australian manufacturers are recognised world leaders in manufacturing water savings, storage, treatment and recycling products.[75]

ANALYSIS OF CLIMATE CHANGE MITIGATION OPPORTUNITIES TO ADDRESS ENERGY AND RESOURCE INPUT COST RISKS

As well as climate change related risks, the manufacturing sector faces a number of risks (Table 2) if they do not embrace action to achieve operational energy efficiency and "green" low carbon product differentiation. This is because

- The difference now in energy and water costs of "green" manufacturing leaders per tonne of product produced compared to "laggards" is now between 30% and 50%. With electricity and water price rises forecast to continue, manufacturing companies cannot afford to give such a cost advantage to their competitors.

- Global markets for energy efficient and low carbon technologies are growing exponentially. The market value for energy efficiency is already US$164 billion each year.[76] Many manufactured appliances and products use much more energy and emit far more greenhouse gas emissions during the lifetime of their use than in their manufacture**.**

Hence manufacturers can build customer loyalty by designing appliances and products to use significantly less energy, to both reduce greenhouse gas emissions and save their customers money.[77] Such an approach allows manufacturing companies to directly address their major energy risks and opportunities.

Risks from higher energy costs and strategies to reduce exposure

The average Australian national electricity price has roughly doubled over the last decade largely due to investment in electricity infrastructure and partly due to the carbon price. The investment in LNG plants for export in Australia is forecast to see significant domestic natural gas price rises for local manufacturers. Even a 5% shift in energy prices could impact per share earnings by as much as 15% in energy intensive manufacturing industries.[78] Companies seeking to minimise their energy costs and greenhouse gas emissions are most effectively lowering the risk of exposure to energy and carbon price rises, thereby protecting shareholder value. Analysts should ask if manufacturing companies are doing the following to manage and reduce energy costs.

Cut energy costs through cost effective climate change mitigation strategies

Numerous profitable strategies exist for manufacturers to reduce operational energy costs and greenhouse gas emissions such as energy efficiency, co-generation, waste heat recovery, fuel shifting, and material reuse and recycling. Independent academic studies show the significance of energy efficiency and cogeneration potential for the manufacturing sector (see Figure 5).

Cut energy costs by using more energy efficient industrial and manufacturing equipment

Studies show a significant amount of energy is consumed by energy hungry plant equipment. It is relatively easy to improve energy efficiency and reduce costs by upgrading such equipment. This soon will become more straightforward to do, as it is highly likely that minimum energy performance standards will be expanded to include most industrial equipment. To date, the COAG Equipment Energy Efficiency (E3) program has focused on domestic appliances. According to Australian Government figures, if industrial equipment were included, it would save at least $1.5 billion per annum in industry energy costs.[80]

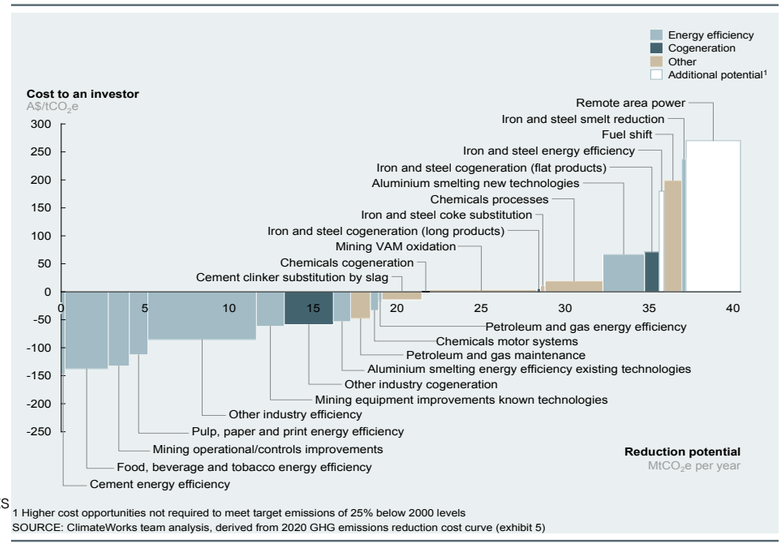

Figure 5: Manufacturing sector - greenhouse gas mitigation cost curve (Source: ClimateWorks Australia, 2010[79])

Cut energy costs by managing production to reduce energy usage during peak demand periods

In 2008, Adelaide Brighton Ltd estimated its self-management of electricity cost risk led to savings of over 35% in electricity costs since 2001, compared to the lowest-cost retail contracts it found available.[81] Boral's Berrima cement works also seeks to manage consumption when possible for some of its processes so as to reduce energy costs. For example, plant operators may program the hours of cement milling each day based on the time of use tariff structure, the cement consumption rate, the cement milling rate and the product available in storage.[82]

Opportunities for new sources of revenue from National Electricity Market reform

Recent rapid increases in electricity prices have been largely the result of historically high levels of investment in Australia's electricity network due to a supply side focus, stronger reliability standards and the replacement of aging network infrastructure. Part of the justification for this has been the need to invest to meet rising peak electricity demand. For example, in New South Wales, capacity to cater for less than 40 hours a year of electricity consumption (or less than 1 % of time) accounts for around 25% of retail electricity bills. The Australian Energy Market Commission (AEMC) has identified substantial demand management opportunities in the Australian electricity system that could lead to savings of $4 - $12billion over the next ten years. Significantly, the AEMC, set up by the COAG Ministerial Council on Energy, recently recommended reforms[83] of the National Electricity Market to facilitate demand-side management for commercial and industrial energy users. Such a system would pay users for their demand response to the wholesale market at the prevailing spot price. AEMC suggests ideal consumers include heavy industry and general manufacturers.[84]

Energy efficiency opportunities with low upfront investment costs

Numerous financing options enable industrials and manufacturers to reduce exposure to rising energy costs and maximise the opportunities listed above, through investment in energy efficient equipment, without incurring significant upfront costs. These are important because many energy efficiency opportunities for the manufacturing sector often have a one to four year return on investment. Analysts should ask if companies have awareness or are taking advantage of any or all of the following financial strategies to reduce exposure to carbon and energy cost rises.

- **Leasing energy efficient lighting and equipment –** Leasing equipment enables companies to avoid upfront costs. It allows them to manage energy efficiency projects without significantly negatively impacting on their cash flow even in the short term. Energy efficient equipment leasing monthly payments may be up to 100% fully tax deductible operating expenses.
- **On-bill financing –** This method of financing involves a partnership between manufacturers and electricity providers. The electricity provider pays for the upfront costs of more energy efficient equipment. Repayments are made to the electricity provider through the manufacturers' regular power bills. Once the manufacturers have paid off the upfront cost of the energy efficient equipment, the ownership of the energy efficient equipment is transferred to the manufacturer. Repayments can be equal to or less than the energy cost savings achieved ensuring your business incurs no expenses along the way.
- **Energy performance contracts (EPCs) –** Through this approach to energy efficiency financing, energy service companies (ESCOs) guarantee reduced energy bills for large sized businesses, by
  - identifying potential energy efficiency cost savings in the business
  - commissioning and funding a retrofit of the business with more energy efficient lighting and equipment
  - using the energy cost savings to repay, within one to four years, the upfront costs incurred by the ESCO.

Strategic positioning for energy efficient/low carbon manufactured product markets

Many manufactured appliances and products use 90%+ energy during the lifetime of their use rather than during their manufacture (Table 7). Increasingly, customers expect manufactured products to operate as energy efficiently as possible to help reduce business and household costs in an environment of rising energy prices.

Table 7: Energy use of manufactured products over the life cycle is dominated by the "use phase".

Type of Product – A Sample - Transportation Vehicle, Manufactured Products, Industrial Equipment	Percentage of Total Life Cycle Energy Consumed During the "Use" Phase of the Life Cycle
Cars, SUVs, pickups, buses	65% - 74%[85]
Family sedan	85%[86]
Passenger transportation (private and public)	63% - 70%[87]
Aircraft	69% - 79%[88]
Appliances	97%[89]
Lighting – all forms	98%[90]
ICT network and mobile phones (eg. 2G and 3G, not office network)	79%[91] - 84%[92]

Hence manufacturers can build customer loyalty by designing appliances and products that use significantly less energy to save their customers money.[93] This, and the fact that energy efficiency standards for manufactured products are rising around the world, is driving exponential growth in markets for energy efficient manufactured products.[94] In a recent survey of US manufacturers, over 90% stated that designing manufacturing products to be more energy efficient will be critical to remaining competitive in the 21st century. Manufacturers also play a key role in manufacturing low carbon renewable energy technologies and components. The Australian Government provides grants through the Clean Technology Innovation Program to assist Australian manufacturers design and commercialise low carbon technologies and energy efficient products. Already there are numerous manufacturers in Australia making energy efficient products for analysts to investigate as potential options for investment.

Improving the energy efficiency of manufactured products across national economies greatly reduces greenhouse gas emissions and costs to business and households.

Improving the energy efficiency of manufactured products is a key objective for most governments internationally including Australia where *The Greenhouse and Energy Minimum Standards (GEMS) Bill 2012* broadened coverage in Australia and increased standards. This is a global trend and analysts should favourably review manufacturers which are both well ahead of the curve and with products that are cost competitive with current inefficient models.

Risks and opportunities from rising and more volatile resource commodity prices

Since 2000, global metal prices have risen by 176%, rubber prices by 350%, and food prices by over 100 percent. This escalation in global resource commodity prices creates both risks from significant rises in resource input costs and profound opportunities for manufacturers of in-demand materials such as rubber or food products. Improving resource productivity through product stewardship, material efficiency, onsite recycling and by diversifying supply chains to purchase more recycled materials can help reduce resource input costs, waste disposal costs and greenhouse gas emissions. Increasingly, regulatory requirements require manufacturers to design products to maximise the potential for remanufacturing and recycling. Recycling of metals, glass, plastics and organic wastes all achieve material savings of greenhouse gases, input resource costs and energy costs.

Risks and opportunities from disruptive manufacturing technologies

The rate of technological innovation is higher than at any time in human history. Analysts need to be aware there are potentially disruptive technologies to transform manufacturing and leave laggards in their wake. Analysts should ask manufacturers if they are reviewing innovations to ensure new super-efficient technologies are not threatening their market share. For instance, additive manufacturing has the potential to transform many areas of manufacturing, whilst using up to 90%[95] less materials to produce products leading to at least 50% energy, water and material savings over the life cycle of product manufacture. Remanufacturing parts through advanced additive manufacturing and surface treatment processes can also return end-of-life products to as-new condition[96], achieving 75% - 98% energy savings compared to making new parts.[97] This is just one of numerous potentially disruptive manufacturing technologies emerging globally. Clearly, those companies with the patents to develop a new generation of low carbon manufacturing processes and products are positioned to experience significant profit growth in a carbon constrained world. Analysts should ask if manufacturing companies have partnerships with R&D bodies to ensure they do not forego major opportunities to commercialise the next generation of low carbon technologies.

CONCLUSION

The manufacturing sector is a highly capital intensive industry with long life assets and long supply chains. While the manufacturing sector is already vulnerable to extreme weather events such as hailstorms and flooding, climate change is forecast to increase the exposure of manufacturing companies to these risks (see Table 1). The manufacturing sector is also vulnerable to rising energy and input costs. These are best addressed by investing in energy efficiency, as well as, where appropriate, onsite heat and power recovery, and water and materials efficiency. These strategies provide good returns on investment and reduce the risk of energy price rises (see Table 2).

The manufacturing sector also has significant revenue enhancing opportunities from investing in both low carbon energy efficient manufactured goods as well as manufactured products which help enable climate change adaptation. Such strategies have yielded significant returns to investors from leading global manufacturers over the past decade.

As per the diagram in the *How to use this guide* section, investors can use this guide to understand these risks and opportunities faced by manufacturing companies. The steps investors may wish to follow to incorporate climate risk and opportunity into investment processes include:

- assess company specific exposures for their severity and timeframe, current and future
- assess the company's response to these exposures and opportunities
- adjust company valuation assumptions based on materiality
- engage the company on outstanding exposures and their response.

In order to perform these steps, investors may gather information on the following issues regarding manufacturing company practice:

- How does the company assess the changing risk to their assets from climate change?
- Does the company consider it is exposed to the risks identified in this report?
- What level of exposure does the company consider it faces?
- What are the upstream and downstream risks to company operations from climate and energy cost risks?
- Is the company building resilience into its assets to adapt to climate risks? If so how and when?
- Does the company benchmark its energy performance? If so how?
- Which of the energy risk and carbon mitigation measures has the company already implemented?
- What management systems does the company have in place to address the risks identified?
- What does the company see as the priority energy cost and carbon mitigation opportunities for the future?
- How do the opportunities align with future capital expenditure plans?
- What governance process do you have to make purchase, development, management and disposal decisions?
- What do you believe are the barriers to implementing adaptation and mitigation measures?
- Does the company have a disaster response plan?
- What is the disaster response plan for business interruption and what does it mean to investability?
- What is the company's preferred channel for reporting progress on these matters to investors?

A discussion with a company incorporating these questions and the analysis in this report should provide the basis for a constructive and relevant dialogue.

Investors should be mindful of existing disclosures by companies on climate risk. A similar, but generic list of questions can be found in the CDP annual questionnaire. Investors should refer to the CDP responses of companies to identify answers already provided. Many companies will have disclosed at least some climate risk and opportunity information. CDP company responses can be found at the following link, or investors can contact IGCC for assistance.

https://www.cdproject.net/en-US/Results/Pages/responses.aspx

IGCC will continue its work with members and company engagement partners to support the implementation of this analysis on the manufacturing sector in investment processes. Users of this document are encouraged to provide feedback to improve the quality and relevance of the guide for investors.

KEY RESOURCES

Adapting to Climate Change – Manufacturing Sector

Australia Industry Group (undated) Managing the Risks from Climate Change: An Adaptation Checklist
http://pdf.aigroup.asn.au/environment/Adaptation_checklist.pdf

Climate Change Risk, Adaptation and Mitigation Opportunity Assessment Guides

Smith, M. (2013) Climate Change Risk, Adaptation and Mitigation Opportunity Assessment Guides for Manufacturing, Food and Beverage Processing and (with Stasinopoulos, P.) Product Manufacturing. DIICCSTRE and ANU. All three guides are available at
http://cci.anu.edu.au/news/article/?id=climate-change-risks-and-opportunities-sector-guides-for-investors-business-and-educators

Climate Change Mitigation Strategies

Worrell, E et al (2010) Managing Your Energy: An ENERGY STAR® Guide for Identifying Energy Savings in Manufacturing Plants. Ernest Orlando Lawrence Berkeley National Laboratory - Environmental Energy Technologies Division
http://www.energystar.gov/ia/business/industry/downloads/Managing_Your_Energy_Final_LBNL-3714E.pdf

Profitable Climate Change Mitigation Strategies – By Subsector

ClimateWorks Australia and DRET (2013) Industrial Energy Efficiency Data Analysis - Detailed project results - Manufacturing sub-sectors at http://www.climateworksaustralia.com/publications.html

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