A Climate Risk Report

Climate Solutions 2: Low-Carbon Re-Industrialisation

A report to WWF International based on the Climate Risk Industry Sector Technology Allocation (CRISTAL) Model

Executive Summary

Climate Risk Pty Ltd provides specialist professional services to business and government on risk, opportunity and adaptation to climate change.

www.climaterisk.net

Climate Risk

WWF

Climate Risk Pty Limited (Australia)

Sydney: + 61 2 8243 5767

Brisbane: + 61 7 3040 1621

www.climaterisk.net

Climate Risk Europe Limited
London: + 44 752 506 8331

This report was prepared by:

Dr. Karl Mallon

karl@climaterisk.com.au

Dr. Mark Hughes

mark@climaterisk.com.au

Sean Kidney

sean@climaterisk.net

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This report was commissioned by:

WWF-Australia
Level 13, 235 Jones Street
Ultimo NSW 2007
Australia
Tel: + 61 2 9281 5515
Fax: + 61 2 9281 1060

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For WWF International correspondence:

Dr. Stephan Singer
Director, Global Energy Policy Program
WWF International
c/o WWF European Policy Office
168 Avenue de Tervueren
Brussels 1150
Belgium
Tel: + 32 2 743 8817
ssinger@wwfepo.org

Executive Summary

Re-Industrialising to a Low-Carbon Economy

This report models the ability of low-carbon industries to grow and transform within a market economy. It finds that runaway climate change is almost inevitable without specific action to implement low-carbon re-industrialisation over the next five years. The point of no return is estimated to be 2014.

Climate Solutions 2 recognises that every industry has constraints on its ability to grow caused by limitations of resources, technology, capital and the size and skills of its workforce.

These limits are measurable and make it possible to calculate, with considerable sophistication, the speed required to re-industrialise the energy and non-energy sectors to create a low-carbon economy in time to prevent runaway climate change.

Climate Solutions 2 accesses historical data and uses a variety of models to reach its conclusions. Two scenarios have been considered in this report:

- Emissions cuts of 63% relative to 1990 levels; and
- Emissions cuts of 80% relative to 1990 levels.

Under both scenarios, every key low-carbon resource and industry must be under their maximum rate of development by 2014. For the 63% reduction scenario, each of these resources and industries must grow at between 22% and 26% every year until they reach a scale that provides reasonable certainty of achieving the necessary global emissions levels by the mid-century.

In the second scenario, there is a significantly better chance of avoiding warming of 2°C if emissions levels are 80% below 1990 levels by 2050. However, to achieve this outcome requires the re-industrialisation process to commence immediately with growth rates of between 24% and 29% every year until deployment scale has been achieved. In addition, emissions abatements from the forestry and energy efficiency sectors must be at the upper end of what is technically possible.

The good news is that the resulting economies of scale from these low-carbon revolutions will create major long-term savings and returns when compared to the business-as-usual trajectory, especially in the energy sectors.

Where We Are Now

Higher Atmospheric Greenhouse Gas Levels than Expected

The current level of carbon dioxide in the atmosphere is 386 ppm (parts per million) while the total greenhouse gases are estimated to be 463 ppm (Tans 2009). This is precariously close to the approximate 475 ppm upper limit (for greenhouse gases) that current literature predicts makes it possible to return to a stable 400 ppm (Meinshausen 2006). Beyond this level, runaway climate change grows increasingly likely. At present, the rate of increase in atmospheric carbon dioxide has not yet begun to slow and, in fact, may be accelerating.

The Development of Low-Carbon Industry is Too Slow

This report clearly identifies that the key constraint to meeting emissions levels needed to prevent dangerous climate change is the speed at which the economy can make the transformation to low-carbon resources, industries and practices. Today, only three out of 20 industries are moving sufficiently fast enough.

There are Less Than Five Years to get Low-Carbon Re-Industrialisation Underway

To avoid major economic disruption, the report's modelling indicates that world governments have a window that will close between now and 2014. In that time they must establish fully operational, low-carbon industrial architecture. This must drive a low-carbon re-industrialisation that will be faster than any previous economic and industry transformation.

Carbon Trading Schemes, Alone, are Not a Sufficient Solution

By itself, an emissions trading scheme will not promote the growth of important but initially higher-cost technologies. A comprehensive plan for low-carbon industrial development is an integral part of the solution. If this window is missed then economically disruptive "command-and-control" style government intervention will be necessary to focus industrial production on the climate change challenge.

How to Achieve a Low-Carbon Economy

The Industries that will Lead the Way

Clean energy generation, energy efficiency, low-carbon agriculture and sustainable forestry must lead the transformation to a low-carbon economy. It is important to note that solutions that extract and store carbon from the atmosphere and biosphere, such as biomass energy production with carbon capture and storage (CCS), have not been used as part of the suite of resources in this report but are likely to be required at some stage if constraints on fuels can be resolved.

Rapid Expansion of Clean Industries

This report's modelling shows that to get key industries to a sufficient scale of deployment, from 2010 they will need to grow by 22% every year in the minus 63% scenario and by 24% every year in the minus 80% scenario to achieve the necessary cuts on 1990 levels. The scale of this re-industrialisation cannot be underestimated. Every year of delay will increase the level of growth required and increase costs.

Should re-industrialisation be delayed until 2014, low-carbon industries would need to sustain an annual growth rate of about 29% to have a greater than 50% chance of avoiding 2°C of global warming. This upper rate appears to be the limit of plausible sustained industrial growth, so further delays will tip the probability in favour of runaway climate change and its consequences.

Stable Investment Environments

Low-carbon re-industrialisation will require each government to create a secure, long-term investment environment to allow for major increases in the scale of production and installation of low-carbon technologies. This includes technologies and resources that will take two or more decades to reach commercial viability.

Investing in a Low-Carbon Economy — Costs and Returns

Long-Term Investment

Transforming to a low-carbon economy will require substantial investment in resources and infrastructure. Many of these investments will eventually become commercially viable in their own right.

The investment required to cover the additional cost of renewable energy relative to fossil fuel energy is about US$6.7 trillion in the minus 63% scenario and US$7.0 trillion in the minus 80% scenario. If the ongoing costs of CCS out to 2050 are also included, these costs would be increased by as much as US$10 trillion.

The modelling indicates that annual expenditure will peak at around US$375 billion a year in the minus 63% scenario and US$400 billion a year for the minus 80% scenario by 2025 and then start to decline. With sufficient up-front capital, energy efficiency measures will be cost-effective immediately or over a very short time period. Forest and CCS initiatives will require ongoing funding.

Since global agreements on emissions and carbon pricing are not yet in place, this report takes the conservative stance of applying no carbon pricing for the minus 63% or minus 80% scenarios.

Tipping Point into Profit

Within the period from 2013 to 2049, the average production cost of each renewable energy technology around the world is forecast to become cheaper than energy produced from their fossil fuel competition. In countries with high energy prices, this renewable energy cross-over will occur soonest.

Returns on Investment

Government, industry and institutional investors can expect to see the benefits of their investment in transforming the energy sector from 2013. This is the point when the first of the renewable energy technologies starts to outperform the current fossil fuel, business-as-usual model.

The scale of renewable energy savings from 2013 to 2050 is expected to be in excess of US$41 trillion for the minus 63% scenario and US$47 trillion for the minus 80% scenario.

Implications for Government, Industry and Investment

This report indicates that to avert runaway climate change, an international agreement on greenhouse emissions must be augmented by a program to rapidly develop a broad suite of low-carbon industries. This program must develop all low-carbon energy sectors concurrently – even those not initially profitable – and on an unprecedented scale. This means that:

- The private sector must be prepared for a massive scale-up of the low-carbon sector and not stand in the way of this transformation. It must deliver cost reductions through economies of scale.
- The investment community must commit tens of trillions of dollars, but can be rewarded with secure substantial long-term returns.
- Governments must create a stable long-term investment environment that fosters a secure market for all low-carbon industries and their investors.

Explanation of Major Findings

The Implications of an Upper Limit to Industrial Growth

A central axiom of the modelling in this report is that there are real-world limits to the rates at which companies and their industries can grow. In the energy sector, growth rates of less than 5% are typical. In the new, renewable energy sector, only a few industries have been able to sustain growth rates above 20% for long periods.

The real-world constraints to industrial growth include access to skilled people, access to resources, access to plant and machinery for manufacturing, installation and operation, and access to capital for both manufacturing and projects. Rapid growth can be just as hazardous for a company and industry as inadequate growth. Therefore, it is important when modelling the growth of low-carbon industries to establish a plausible upper limit of growth for companies and industries participating in a very rapid low-carbon re-industrialisation.

This upper limit reflects the point at which companies are likely to either fail due to excessive growth or turn away opportunities in order to maintain stability.

In this report, 30% annual average growth is considered to be the upper limit of sustained industry growth in a free market. Beyond this limit, the delivery of consistent growth is not plausible.

Under a "command and control" scenario – typically only observed during times of war – it may be possible to achieve annual growth rates slightly beyond 30% by forcing the reallocation of resources. However, since most renewable energy industries rely on specialised skills, equipment and materials, any benefits obtained by such forced resource reallocation are likely to be limited.

The 30% upper limit to industry growth used in this report reveals a very limited window of opportunity and, therefore, very little margin for policy error. Initially, delays in establishing low-carbon industries can be compensated by increases in the growth rate. However, at some stage these delays will no longer be able to be recovered by growth rate increases (when they reach their upper limit) and this will inevitably lead to delays in delivering

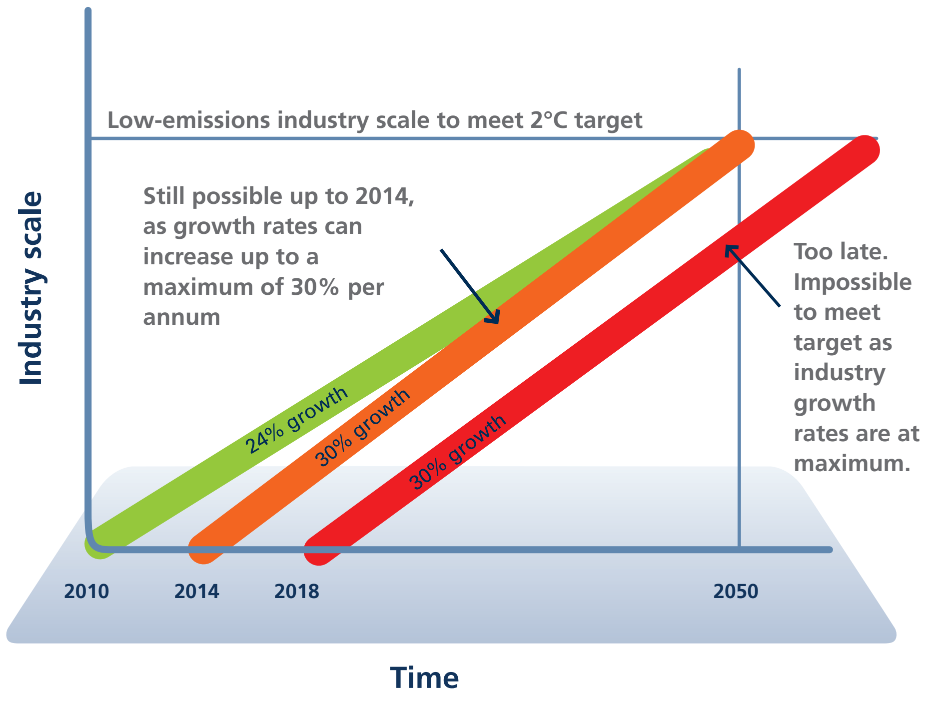


Figure 1: Missing the target. This schematic diagram illustrates that initial delays can be made up by increased growth rates. However, when the upper limits to growth are reached, further delays result in a shortfall in deployment in later years.

the low-carbon outcomes (see Figure 1). The consequence of such delays will be a failure to meet the cumulative and annual emissions reduction objectives needed to prevent runaway climate change.

The modelling indicates that it is still possible to achieve emissions levels that are 80% below 1990 levels by 2050. Reaching these levels creates a high probability of avoiding global warming of 2°C. To achieve an 80% reduction by 2050 requires immediate low-carbon industrial development growth rates of 24% every year until large-scale deployment has been achieved. At the same time, countries must maximise all plausible emissions abatement opportunities in the forestry sector and boost the adoption of energy efficiency measures.

This report finds that if re-industrialisation across all low-carbon sectors – including clean energy, forestry and agriculture – does not get underway until after 2014, then the probability of exceeding 2°C of warming and the risks of runaway climate change occurring will exceed 50%.

For all emissions abatement scenarios examined in this report, it is assumed that there are no major changes in population growth, GDP growth or fundamental lifestyle choices. If such activities were curtailed over the long-term, the low-carbon industry growth rate requirements reported here may be eased somewhat.

The Inadequacy of Trading/Carbon Price Alone

Should the development of low-carbon industries be unduly delayed, the constraints on industrial growth will create a situation where industrial production cannot respond to price signals from the market. That is, despite an increasing price for carbon, the industries most able to provide abatement at those prices will not be sufficiently developed or able to grow fast enough to meet the demand. They will be constrained by shortages of skills, materials and production output.

One foreseeable cause of delay is the exclusive use of price-based mechanisms like emissions trading. These mechanisms support the development of least-cost industries first, essentially fostering a sequential industrial development process.

This report compares a sequential development scenario with a concurrent development scenario. The comparison reveals that for the sequential approach, emissions levels in 2050 are more than double those in the concurrent case when using the same industry growth rates (see Figure 2).

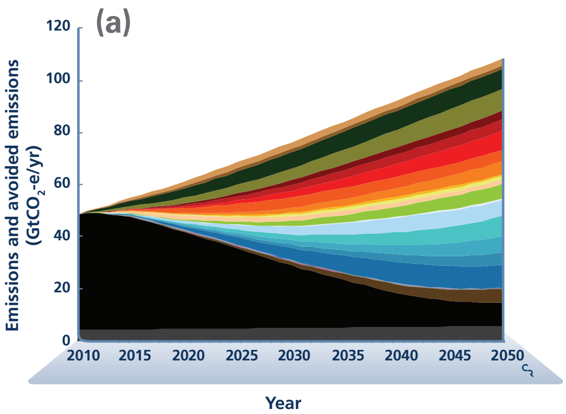
Even if price-based mechanisms like emissions trading were accompanied by policies that ensured the sequential development of low-carbon industries, there would still be a need for investment in the early stages of development. Figure 3 shows that even for high carbon prices there is still a cost shortfall for low-carbon energy generation relative to that of fossil fuels that would need to be met by investment of some kind.

Investment and Returns

Changes in energy prices, driven by economies of scale, will be an intrinsic component of low-carbon re-industrialisation. For example, currently renewable energy technologies generally cost more than fossil fuel-based energy and are, therefore, priced out of the market. However, once renewable energy technologies are driven to larger scales, this situation reverses.

Since the fuels for renewable technologies (i.e. biomass, wind, sun, etc.) are obtained at zero or low cost, the core cost stems from building plants to extract that energy. Empirical evidence provides a reliable guide to the decline of future costs.

By contrast, fossil fuel costs are likely



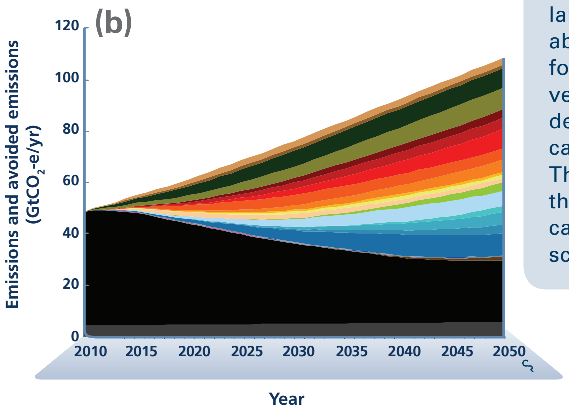


Figure 2: There is a large difference in the abatement outcomes for (a) concurrent versus (b) sequential development of low-carbon industries. This figure illustrates the difference in the case of the minus 63% scenario.

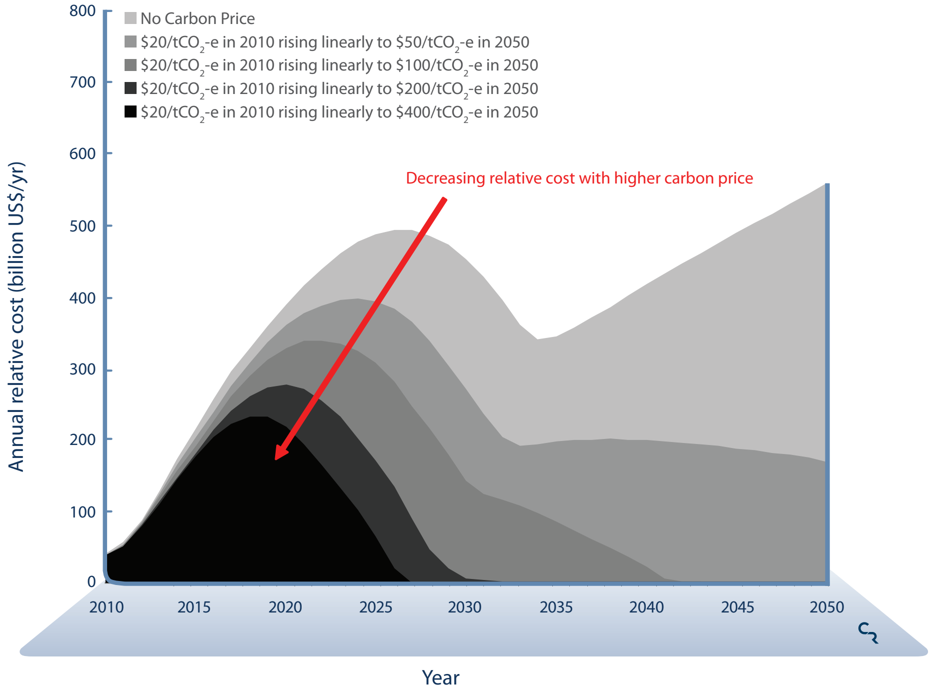


Figure 3: The impact of various carbon prices on the annual cost of low-emissions energy generation industries relative to fossil fuels in the minus 63% scenario. This annual relative cost approximates the amount of investment required for all low-carbon energy generation industries (including CCS). This figure shows that even high carbon prices do not overcome the interim cost-shortfall of low-carbon energy generation.

to increase in price due to rising fuel extraction costs and the cost of managing greenhouse gas pollution. *Climate Solutions 2* assumes that fossil fuel prices will increase by 2% every year but does not include a cost of carbon.

In this report, the point at which the first renewable energy industries, such as wind and small hydro power, start to create net savings is 2013 (assuming no retardation of learning rates). By 2049, all major renewable resources will be able to provide energy at, or below, those costs projected in the business-as-usual scenario. The final resources projected to cross the viability line are wave and ocean energy generation.

In many countries with higher energy prices, the savings will start being realised much earlier.

This presents a long-term investment picture in which short-term price support to achieve economies of scale is repaid with long-term returns from the cost savings (see Figure 4). This type of investment and return profile is most appropriate for institutional and pension fund investments. It may also lend itself to the use of "climate bonds" – structured by governments, investors and industry specifically to support this process.

Conclusions

The current trajectory of global greenhouse gas emissions is on course to trigger tipping elements that are forecast to unlock runaway climate change.

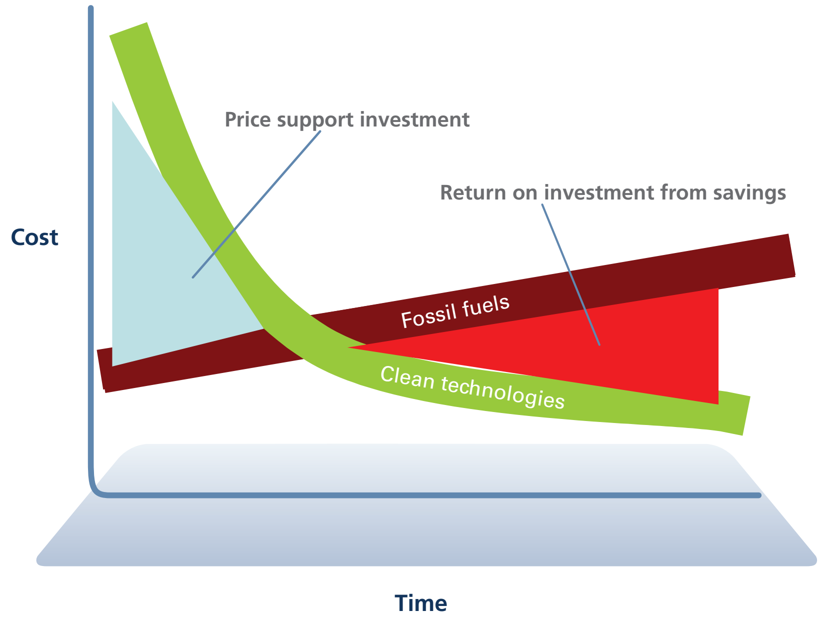


Figure 4: Short-term price support for renewable energy technologies to achieve economies of scale will result in long term cost savings.

However, a small but rapidly closing window of opportunity remains to prevent this eventuality. This window is defined by the time needed to develop and deploy low-carbon industries at a scale that will prevent a 2°C rise in global temperatures. In order to proceed through this window of opportunity, the process of low-carbon re-industrialisation must be at full speed no later than 2014.

Beyond 2014, this report finds that there is a "point of no return", where market-based mechanisms cannot be expected to meet the abatement requirement. At this point, the probability of runaway climate change is considerably greater than the probability of keeping the global average temperature from rising more than 2°C.

This finding has important policy implications and opportunities.

- Policy implications: 24 critical low-carbon resources and industries will be needed to meet the required emissions target. This implies that schemes such as carbon pricing and trading – which foster development of one technology after another, with least-cost technologies being activated first – are not sufficient by themselves. Instead, international policy is required to simultaneously drive the worldwide ramping up of the full suite of low-carbon industries and practices identified in this report.

- Opportunities: The good news is that the resources, technologies and industries required for the transformation are all available; the rates of growth are plausible and the trillions of dollars of investment required are within the capacity of the institutional investment sector.






Climate Risk Pty Limited (Australia)
Sydney: + 61 2 8243 5767
Brisbane: + 61 7 3040 1621

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