# A Clean Energy Tipping Point?

**A report to the Tasmanian Climate Action Council on Global Trends in Electricity Markets as they relate to Climate Change**

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# What if the dominant assumptions about energy futures are wrong?

Forecasting energy markets in the context of climate change has layers of unpredictability – uncertainty about technology development paths, unknown government regulatory responses and the ever-present general unpredictability of markets and economics.

However there is now sufficient evidence to suggest that the dominant view about how energy markets will unfold over the next few decades has a reasonable chance of being completely wrong, with dramatic implications for investment and business strategy *and* for both energy and economic policy and international climate negotiations.

Of course no one can know for sure, and we don't suggest we *know*. Our point is that most planning by policy makers, utilities, investors, lenders and resource companies is predicated on a world view that has reasonable chance of being flawed and the alternate view – supported by extensive analysis by mainstream experts, financial analysts and companies – should be considered with at least equal weight.

Not doing so poses significant risks of failure for policymaking, company strategy and investment strategy. It also puts national and state economies at risk from unexpected and disruptive change.

## The dominant view

The dominant view is as follows:

> *While renewables will continue with strong growth, fossil fuels will remain the dominant fuel source for many decades – still playing a strong role in the global market in 2050 and for some decades thereafter. While coal is certainly facing some challenges, even that will play a strong role due to the rapidly growing economies of China and India and the overwhelming competitiveness and availability of coal vs all other energy sources. The current fall off in coal prices and investment delays is a cyclical dip and the market will come back.*
>
> *Renewables are doing well and growing fast – better than expected. But their success is really only because they are so strongly subsidised and mandated by government. Furthermore, the very low base of installed capacity now, means even rapid growth won't make much of a dent in global energy supply.*
>
> *These assumptions are based on market fundamentals and therefore only a dramatic shift in policy could change it – and given there's no sign of a global policy shift, business as usual is the correct basis for strategy and local policy decisions.*

## The alternative view

Energy markets have historically been considered in the context of physical resources and their large volume supply into markets defined, in the case of electricity, by centralized energy systems. This results in a view based on large slow moving companies, developing large long-life assets like power stations, mines and oil fields in a context of slow moving shifts in markets, technology and energy supply. The only accepted disruptions are geopolitical ones – wars and political instability in key supplier countries.

That worldview lies at the heart of why most forecasts in this area may be profoundly flawed.

What if the emerging energy system was based on a very different foundation - more akin to ICT technology where change is rapid and market disruption normal. In that world business leaders make strategic bets that can see them grow into one of the world's largest companies in a decade or less, or face equally dramatic declines in the opposite direction.

There are now signs the global energy system may have started the shift to this model and the game changing significance for many industries and society is hard to overstate. These signs include:

- The quite extraordinary drop in solar prices. Imagine other industries facing an 80% price drop in 5 years, with continuing reductions forecast.
- The imminent arrival of residential & commercial energy storage at scale.
- The growth in electric cars, integrating with the above.
- The combination creating the potential for a distributed power system.

With business models facilitated by the internet and related technologies, these shifts alone would be enough to drive dramatic change.

But then we have to add in:

- Climate change and resulting policy support for renewables.
- The public, investor and regulatory backlash against coal.
- China's urgent political need to address air pollution.

Taken together, the combination could spell commercial death for some of the world's largest companies and even whole sectors – in both direct energy production and large energy users like automotive and other transport. Of course that would mean equally dramatic opportunities for those ready to replace them.

While it may first seem surprising that such dramatic risks are being largely ignored by the companies involved, we should in fact expect nothing else. Missing major transformations that are obvious in hindsight is arguably normal operating procedure for business. Consider Kodak's recent "Kodak Moment". Or the demise of various players in the book industry. Or how Tesla is valued at nearly half of GM despite having a fraction of the production volume.

Long delays and denial, followed by sudden tipping points is how business normally changes and the incumbents tend to fail to respond to the evidence around them until it's sometimes too late.

Let's take a look at the electricity industry for a current example.

# A global transformation in the electricity system has begun

A business model that has remained virtually unchanged for the better part of a century is coming to an end.

In the late 1890s, there was a big debate between electricity pioneers Thomas Edison, who believed that electric generators should be located near where the power is needed (distributed generation), and his rivals George Westinghouse and Nikola Tesla, who pushed for large centralised generation facilities.

Centralised generation won; economies of scale led to bigger, cheaper and more distant electric generators and larger and longer transmission lines. This model has held sway around the world and has underpinned government policy and investor assumptions about the industry.

The dominance of that approach is now coming to an end, and a dramatically different market and business dynamic is emerging. Drivers include:

- Climate policy driving large scale deployment of renewable technologies and as a result spectacular price drops, particularly in solar.
- As a result, a range of renewables particularly wind and solar becoming market competitive even at "utility scale".
- This is particularly the case with solar PV now or soon at "socket parity" in a hundred countries (i.e. payments on the cost of a financed solar rooftop system delivers cheaper kilowatt hours (kWh) than the local utility).
- Entrepreneurs deploying disruptive business models and approaches, such as financed solar competing against retail rather than grid pricing and electric cars such as Tesla competing as high end sports cars rather than "eco-friendly cars".
- The size of the opportunity in the potential system transformation is becoming self-fulfilling, with large investment and growth in related areas such as battery storage, smart meters and electric vehicles that will drive further cost reductions.

In combination, these trends are driving major changes through the utility and other industries - disturbing core business models and profitability. Impacts include:

- Utilities facing structural change and a potential death spiral.

- The future of thermal coal considered by many to have shifted in just a few years from strong growth prospects to terminal decline, with new investments now seen as risky.
- The auto industry well underway in its transition to electric cars, leveraging off but also accelerating the renewables/storage trends.

These are not idle forecasts of technology buffs or futurists but active shifts underway in the market with major impacts already felt on market valuations and increasing acknowledgement by industry leaders.

The Economist recently reported that European utilities had lost over $700 billion in market value because of these and related trends. German utility RWE, recently announced its first loss in 90 years – a whopping $3.8 Billion - acknowledging they had overinvested in fossil fuel assets with the CEO admitting, "We were late entering into the renewables market -- possibly too late." He went on to say that his company faced: "the worst structural crisis in the history of energy supply."

Of course the view of what is a "crisis" is determined by your position in the market. Successful dot com entrepreneur Elon Musk has established the electric car company Tesla and is Chairman of solar installer Solar City, both of which are doing very nicely in this "structural crisis". Tesla is valued at over $20 billion (compared to General Motors at $55 billion) and Solar City at $5 billion, both due to their extraordinary growth prospects.

The coal mining industry has suffered large drops in value and the cancellation of many new projects, because its previously rosy future is now profoundly threatened by this transformation and the market has noticed.

Electricity utilities who fail to react adequately face what some of its own leaders have called a death spiral. With households and companies producing their own electricity and using electricity more efficiently, they face both loss of high margin peak pricing and loss of volume.

With the same asset base they have little choice but to increase per unit energy costs, or fixed connection charges, to cover their costs. This then drives households and companies to produce more of their own power reinforcing the trend.

To make matters more challenging the shift is not just technology, but business models and culture.

- Centralised, large-scale generation and grids are characterized by large, capital intensive, highly regulated businesses with high barriers to entry and slow moving transitions.
- Distributed, local generation involves flexible and small systems, characterized by low barriers to entry, diverse technologies and players and rapid consumer driven shifts.

So utilities used to a business culture of multi decade transitions and investment cycles now face a culture more similar to the high tech industry with a consumer culture like smart phones, where products live and die in years not decades.

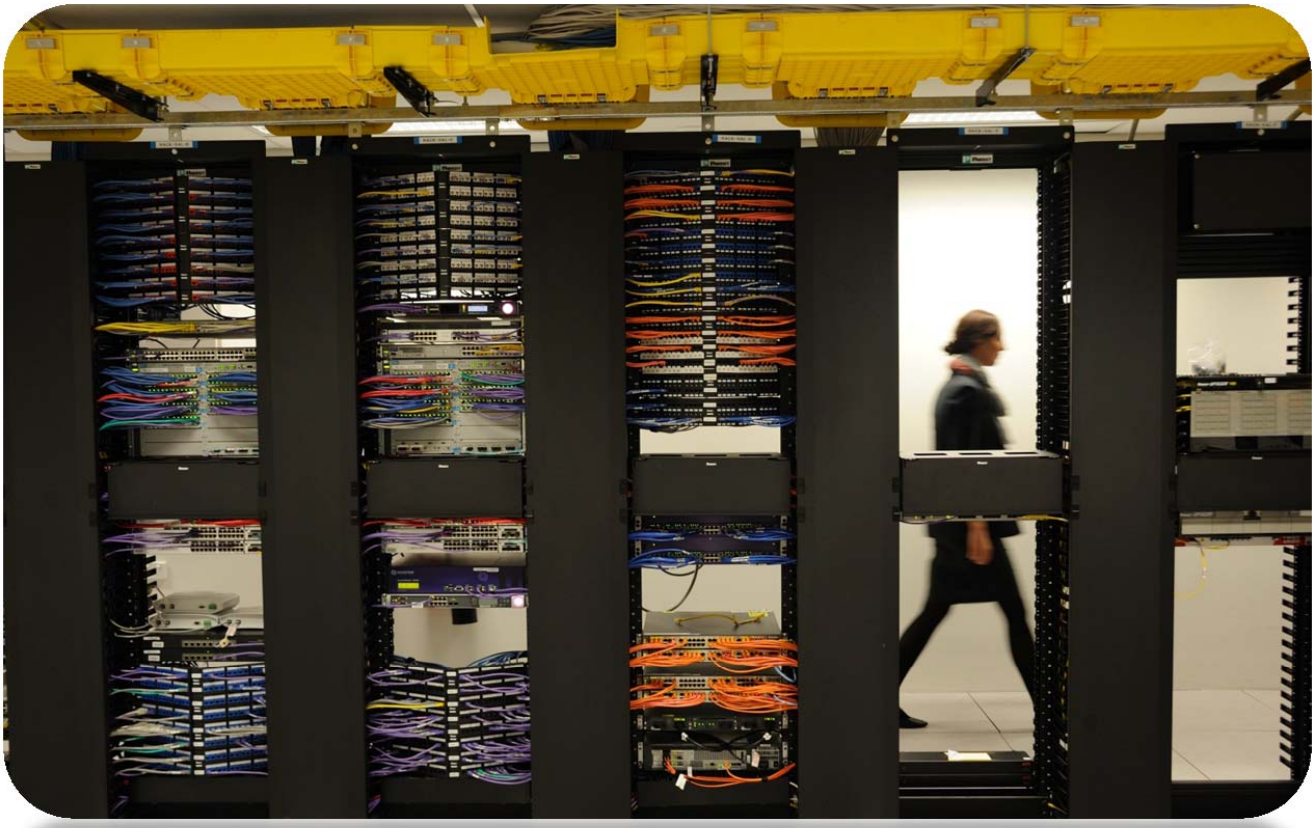
The implications of this major shift are not yet understood by most policy makers or even many large businesses and investors in the market.

# The market, not policy, is now the key driver

The most powerful single driver of this change is that new technologies, mostly focused on distributed generation and storage, are becoming cost competitive. It is already the case for solar and wind but other technologies such as combined heat and power, fuel cells and battery storage are likely to follow or are already there.

The progress of many of these technologies was assisted by policies designed to address climate change and energy supply issues, but they have now got to the point where they have their own economic momentum, independent of policy.

Originally driven by feed in tariffs in countries like Germany and resulting mass production in China, the cost of solar PV has fallen dramatically over the last five years, with cost reductions of around 80 per cent. Researchers such as Stuart Wenham from UNSW say the cost of solar will fall another 50 per cent by the end of this decade. This is supported by leading manufacturers, which are reporting reductions in the cost of manufacturing of 10 per cent per annum. Citigroup also forecast a 50% reduction, with the cost of solar modules likely to fall to 25c/W by 2020.



As a result, in more than 100 countries across the world, there are areas where it is now cheaper for consumers to source electricity from panels on their rooftops than it is for them to source energy from the grid (with all the latter's sunk infrastructure costs). This is known as "socket parity" because solar competes at the retail price customers pay to use power at the socket. This is a game changer because previously all assumptions about solar being "expensive" were based on the generation cost at a power station.

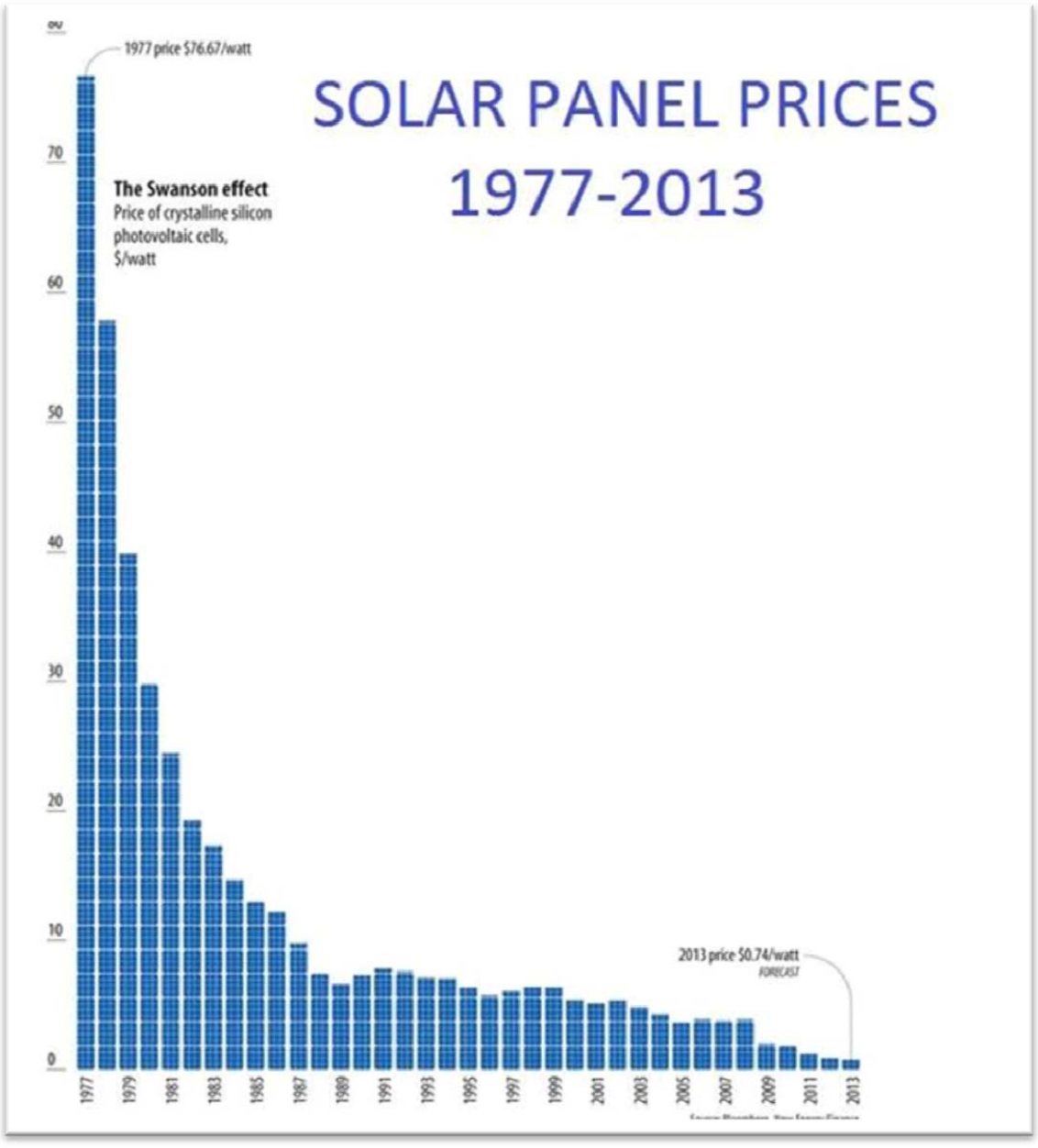
But even the cost of utility scale solar is expected to be comparable to the cost of power from new fossil fuel plants this decade in many countries. In some countries it already has. Bloomberg New Energy Finance estimates that wind power is already cheaper than new coal or new gas fired generation in Australia, and is so in many other countries. Long term power purchase agreements for solar have recently hit 5c kWh in the USA. Such deals are hard to directly compare between countries because of different tax and regulatory systems but it shows the trend clearly. In that example the price without tax breaks was estimated at 7.5c kWh – very close to new gas and cheaper than new coal – but without fuel price uncertainty.

While there is debate about the exact definition and timing of "price parity", the clear trend towards it is the central reason for the tipping point. This is because the market looks at prices being close to parity and then prices in assumptions of increasing climate policy and the risk of price volatility in fuel costs with gas and coal – all translating to increasing investment risk in carbon based energy sources. The result is the market discounting the value of fossil fuel based energy while doing the opposite for renewables - assuming policy support, lower risk and falling prices.

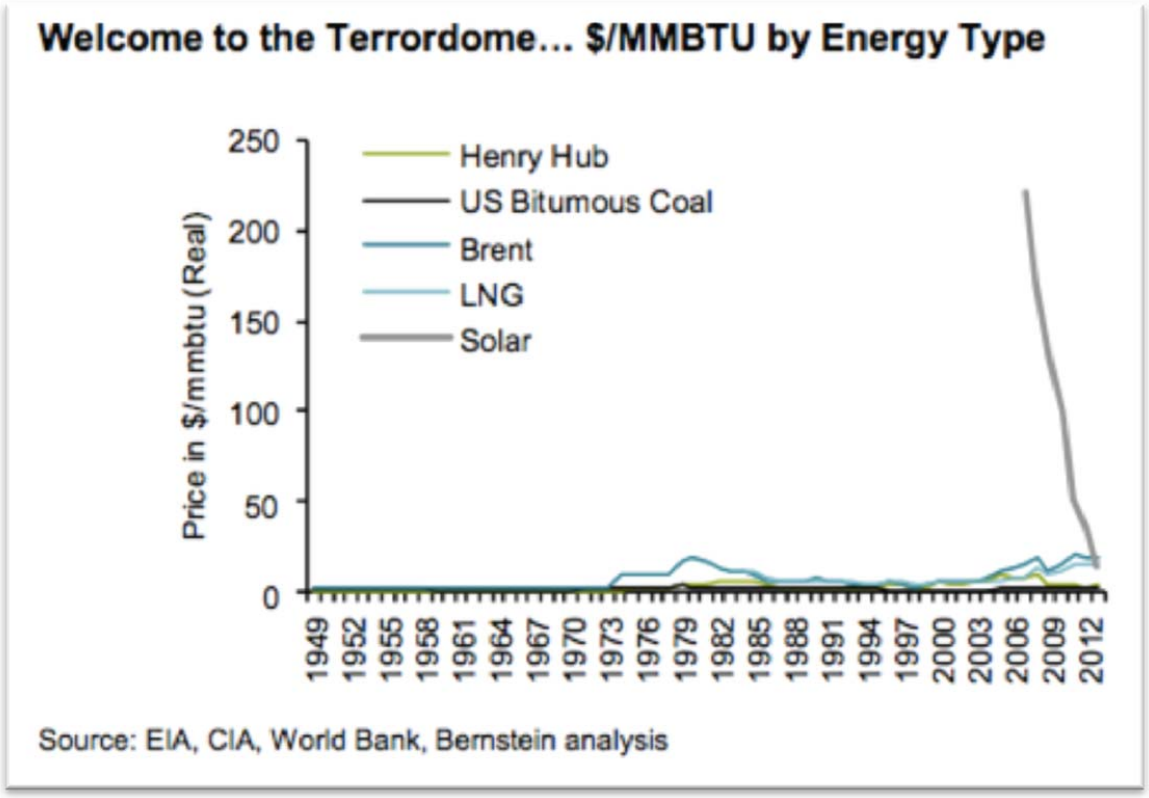
So the market being even close to price parity tips the scales and that's why so many investors have turned the corner - thereby now making the trend self-driving. And as an increasing number of financial market analyses conclude, this point has well and truly arrived.

Of course "energy" is a simple term that describes a very complex and diverse market. So it is important to note the potential for "leakage" from the electricity market dynamics with solar into the global fossil fuel liquid markets. Consider these two graphs below.

The first from Bloomberg New Energy Finance shows the historical price fall of solar.



The second graph, produced by leading US investment manager Alliance Bernstein, shows how solar has made a dramatic price fall to now being able compete with oil, diesel and gas in certain situations.




The striking part of the solar component of the second graph is that it represents just the last few years of the first graph's solar cost fall, i.e. when the cost reduction appeared to be flattening out.

It notes that even though solar represents a fraction of total energy demand (less than one per cent in 2013) it will see dramatic growth in the coming years because of this price competitiveness.

Perhaps the most startling conclusion in their report on this trend is that the continuing price reduction and volume growth of renewables could conceivably lead to energy price deflation within a decade. The idea that prices for oil would be driven down by solar, turns many assumptions about the future of energy on their head.

Alliance Bernstein notes that investors will not wait for energy price deflation to take effect, they will make decisions on the assumption that energy price deflation will occur. This has significant implications for financing flows for both fossil fuel and renewable energy markets, particularly in the context of the debate about carbon bubbles and the investment risk in carbon assets such as coal, oil and gas reserves.

# The impact on business models – far bigger than just pricing

Returning to the impact on electricity markets and distributed power, price comparisons are only one part of the story. Of equal significance is the timing and nature of renewable generation and the way it is viewed and used by consumers.

Rooftop solar right now only makes a minor contribution by volume to the generation of electricity in markets such as Europe, the US and Australia, but its impact on the market has been far greater than the volume would suggest.

Jim Rogers, the outgoing head of Duke Energy, the largest utility in the US, says it is clear that "self generation" or "self consumption" – the ability of household and commercial customers to generate and consume their own power – will disrupt utility business models, leading to a "disintermediation" from customers. "If the cost of solar panels keeps coming down, installation costs come down and if they combine solar with battery technology and a power management system, then we have someone just using us for backup."

The issue has caught the attention of mainstream market analysts. Macquarie Group describes the rollout of rooftop solar in Europe as "unstoppable", while UBS calls it a "no-brainer" for consumers.

The fact that customers can produce energy for themselves at a lower cost is being noticed by investors and analysts. Smart utilities are addressing the issue, realising that the best response is to embrace the new approaches. Citigroup has issued a report on this called "Energy Darwinism", pointing out how utility models are being challenged.

David Crane, the head of NRG, the largest generator in the US (which produces all but 1.5% of its power from fossil fuels) is a good example of a proactive response, stating : "Consumers are realising they don't need the power industry at all. That is ultimately where big parts of the country will go." He wants to help them do that and is adjusting NRG's business model to suit.

# The big surprise: "expensive solar" makes electricity cheaper

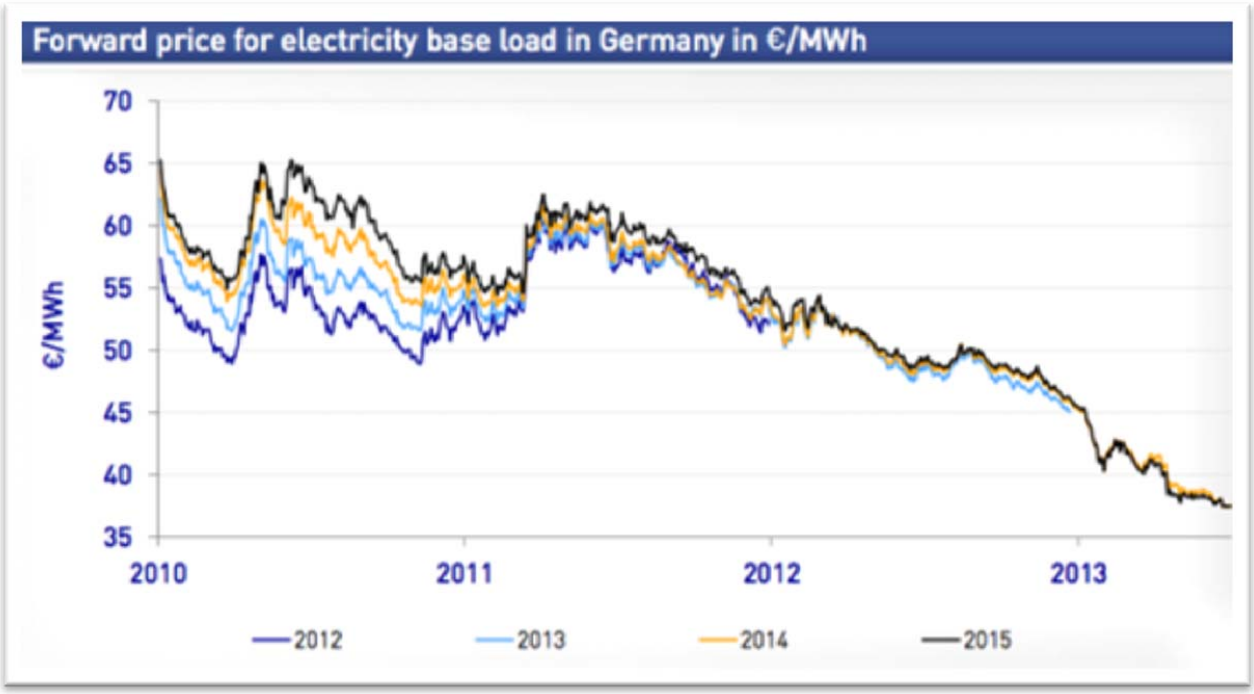
With these developments, the mythology of solar being expensive has taken two big hits. First as above, was the realization that it competes not with generation costs but retail costs – so called "socket parity".

The second is perhaps of more significance because it is shattering utility business models today, causing market chaos for investors. This is the realization that solar has a major impact on wholesale energy prices.

In key markets solar sometimes reduces demand on the grid at just the times of day when the market has traditionally experienced strongest demand and so the highest prices – and the highest margins for base load. This was the time of day utilities generated most of their profits.

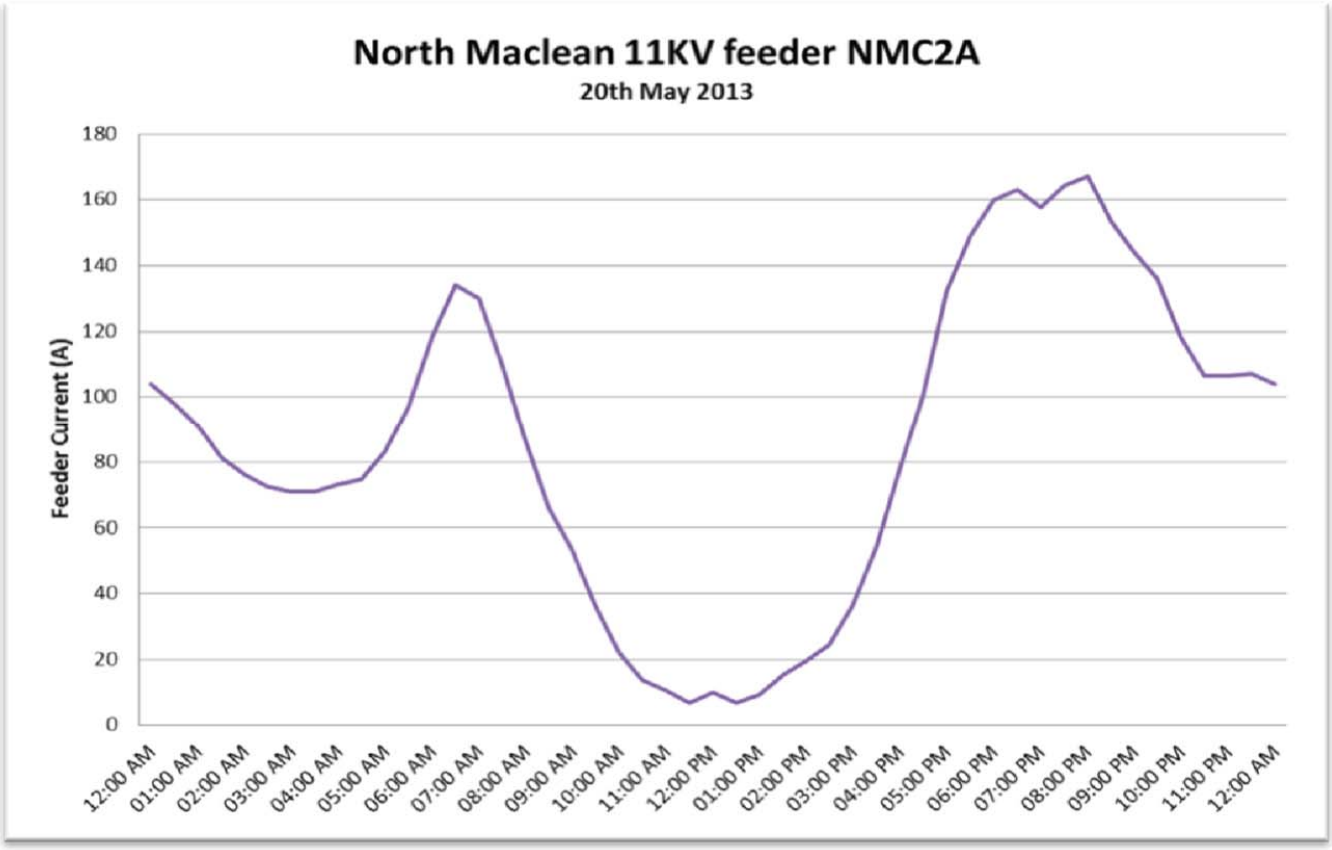
This has been evident in Germany, which has the most amount of solar in any country (33.5GW). On three working days in May, with sunny conditions, the average wholesale price of electricity fell to Euro 1c/kWh (Euro1/MWH) between the day time hours of 6am and 6pm. On June 16, 2013, base load generators actually had to pay the grid 100 Euros/MWH to take their power!

The forward pricing for base load generators in Germany, the country with the most installed solar, tells this story.



In South Australia, which has one of the highest penetrations of rooftop solar in the world, the impact has also been notable, in particular in the recent heatwaves of 2014.

In many strong solar regions, the cost of power at noon is now cheaper than the cost of power at midnight, the opposite of what it used to be. This graph from a feeder owned by Energex, which operates in south-east Queensland, shows why. The use of solar PV has reduced demand from the grid to virtually zero at noon.




This turns old assumptions of solar being "expensive" on their head. Even if solar was to be more expensive per unit of power –now arguably wrong – the ability of solar to reduce peaking load means the average cost of generating electricity falls. So with the right balance in the system, more solar = cheaper overall electricity for consumers.

## Solar and storage

The next phase of this changing business model is the deployment of storage. This helps consumers store and use more of the energy they generate on site – particularly important when the amount paid for exports to the grid is lower than the retail price they pay for imports (now common in Australia with the wind-back of feed in tariffs). This does not mean necessarily going off grid - for example customers with small storage can generate solar power in the afternoon and extend its use into the evening peak.

Most analysts say that battery storage will be competitive within a few years – the US solar company SunPower predicts that it will be offering "home energy systems" combining solar, storage and smart technology by 2015. It has majority share of a retailer in Australia.

In New Zealand, Vector Energy has already offered leases on home energy systems combining solar, storage, and the option of combined heat and power, to its customers. It says this is cost competitive to consumers today.

This is where the system shifts go beyond utilities. Electric car companies are noticing the growth in battery opportunities and see growing synergies, both with electric cars plugged into the grid – for example at home with solar panels on the roof – and as a secondary market for batteries. Electric car maker Tesla is now planning a factory that will take battery costs to a new low – a $5 billion investment most likely alongside Japanese company Panasonic.

## Tariffs and incentives

The German solar boom was sparked by generous feed in tariffs, as Germany sought to generate more of its own electricity to reduce its dependence on expensive imported gas. Despite much criticism about its cost, it has resulted in the installation of more than 33,500MW of solar at a cost to consumers of 59Euro a year, according to IEA data. Gas imports have been reduced and by some estimates more than offset the cost. The tariffs have now been reduced significantly to something approaching a net 1:1 tariff.

Germany, it should be pointed out, has just introduced a feed in tariff for battery storage in households, to encourage the deployment of this technology and to accelerate the fall in the cost curve.

Interestingly, Japan is using exactly the same policy incentive to encourage the deployment of solar and other renewable energy technologies following the closure of much of its nuclear fleet. It has offered generous tariffs, but in just six months it has reduced the installed price of solar systems by 30 per cent. This is expected to fall further. This in turn has enabled Japan to reduce the size of the feed in tariffs, and further adjustments will be made. China offers a similar system, although at a reduced rate. The principal fault of the tariff regimes in many Australian states, most notably NSW and Queensland, was the governments failing to monitor the take-up of the tariffs, or adjust the settings to respond to falling costs.

The net metering system (1:1) that was used in Tasmania until recently, is the same that is used in most US states. A study in California found that the benefits – savings on conventional power, transmission and distribution infrastructure, electricity lost in transmission and emissions reduction – clearly outweighed the negatives of increased metering costs and the lower revenues to cover utility infrastructure costs.

## The implications for the electricity retail market

The reduction in demand caused by solar, and potentially storage, and other self-consumption options presents a challenge for retailers, who have traditionally operated on a model of ever increasing demand. With the arrival of new distributed generation technologies and the further fall in demand driven by greater energy efficiency and drops in manufacturing demand, this old model is dead. Whether these old companies transition or are replaced will be determined by leadership that has an eye for the future, because the answer will not be found in protecting old models.

Traditionally, utilities have delivered electricity to the connection at the front of the house, and have had poor engagement with consumers. But in the future, the battle for market share will take place inside the home or commercial premises, as providers of smart appliances, home energy systems, energy efficiency technologies, and solar and battery providers all compete for a slice of the energy pie – a global market of trillions of dollars in annual revenue.

This will include the sort of retail offerings being contemplated by SunPower and New Zealand's Vector. There are plenty of potential competitors – the makers of smart appliances, software companies, telecommunication companies, or even home security companies that are poised to take advantage of any opportunities in home energy systems.

These dynamics are an important consideration in putting a "fair value" for solar. Utilities face potential repercussions if their customers feel they have been hard done by, and the value of the electricity they produce on their rooftops is not recognized.

The short term focused response by utilities to date has to been to argue for higher standing charges and lower feed in tariffs. If they are successful, this will lead what even some industry leaders call the "death spiral" as it will just encourage customers to take stronger action to further minimize the use of grid power.

## The system advantages of solar

Solar is one of the keys in offering customers – be they households or commercial users – the opportunity to reduce their electricity costs by supplying some of their own energy. So the system impacts of its use are critical. In Queensland, solar has been shown to reduce overall demand, and to have kept a limit on the evening peak, despite the massive growth of air-conditioning and other home appliances. Battery storage will further smooth out the peaks, reducing the need for further network investment.

The CSIRO released research last year suggesting that networks should be able to absorb up to 40 per cent penetration of solar PV without much difficulty. In "thin" regional networks, there is not as much capacity to absorb solar, but distributed generation such as solar in combination with storage options mean that costly network upgrades can be avoided.

# Implications for Tasmania

First we should respond to an often used argument that Tasmania doesn't have much sun. Neither does Germany, or England, or even the northern states of the US – all of which have experienced strong growth in solar because the economics of the technology still deliver savings to consumers. In the UK, a 34MW solar farm was recently installed at a disused WWII airfield in Leicestershire. The cost was $1.60/w – lower than anything built in Australia. It will deliver electricity at a cost of 11c/kWh – on par with wind, and cheaper than new build coal and gas in Australia. And that is only with 2.84 hours average sunlight a day!

The key implication of all this for Tasmanian policy however is not about the falling price of solar and other technologies. Those changes will be globally determined and uptake in Tasmania will proceed based on market fundamentals.

This still has significant implications for the Tasmanian economy, both for job creation and for lowering energy costs for both commercial and residential customers. But more particularly in the Tasmania policy context, is the state's unique position in Australia in having its generation portfolio being low carbon – mostly hydro that is easily "switchable" i.e. the ability to quickly turn the supply on and off.

This is crucial, because the electricity system of the future will be one that focuses on the need for flexible generation to respond to changing supply, filling in the gaps of renewables like solar and wind, rather than the old paradigm of baseload with peaking plants responding to changing demand. The big generators in Europe realize that even new fossil fuel plants need to be flexible - be able to rapidly be switched on and off – if they are to remain economic.

It is clear that even with a moderate amount of renewables markets will see significant change. They are likely to evolve from markets based on the amount of kilowatt hour produced (energy markets) to something approaching a capacity-style market, or – more likely – a hybrid known as a "capabilities market", which would look for flexibility and low emissions.

Tasmania's generation profile is well suited to this new future – offering reliable and low emission generation in its own market, and then able to use export opportunities to the mainland.

The economic and job implications are considerable. The UNSW's Wenham notes that solar modules now make up only a small part of the overall cost of solar systems and this is true of jobs as well. Wenham estimates that 80 per cent of the jobs associated with solar come "on the ground", through installation, financing, maintenance, and associated infrastructure. This presents a serious economic opportunity for Tasmania with a well-considered strategy, with strong local employment opportunities. The state's largest renewable generator, Hydro Tasmania employs around 1,100 people and the solar industry is already significant with around 450 local jobs and considerable potential for growth.

Given this strong foundation there is good news in these global trends. With solar and battery storage offering compelling options for households and commercial customers, Tasmania has an opportunity to exploit this to strengthen its own network and its credentials as a clean energy "battery" to provide low cost, low emissions electricity to residential customers, businesses and manufacturers, and for export to the mainland. This is an economic opportunity worth understanding and acting on.

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