The tax treatment of capital investments in renewable energy

October 2008

David Richardson

Senior Research Fellow
The Australia Institute

Introduction

Rising energy prices combined with technological developments mean that renewable energy sources are becoming increasingly competitive with fossil fuel sources of energy. Mandatory renewable energy targets provide an added incentive to invest in renewable energy sources and the expectation of a modest price for carbon emissions helps encourage new investment in renewables even further. That said, in Australia the investment in renewables has, to date, been relatively small. At the same time, policy makers assert that there is some urgency for Australia and the world to reduce carbon emissions.

The purpose of this paper is to examine the treatment of capital expenses in the renewable energy sector with particular emphasis on the need to introduce accelerated depreciation provisions to help encourage new investment in alternative sources of power. Accelerated depreciation, which is described in greater detail below, refers to the capacity for selected industries to claim bigger tax deductions for the cost of their investments in new equipment in the early years of a project. Such provisions increase the after-tax profit earned by investors and, in turn, the likelihood of such investments taking place.

In Australia today, mining and the airlines are the industries receiving the most generous accelerated depreciation provisions. Given the Australian Government's stated intention of reducing greenhouse gas emissions, it is inconsistent, and inefficient, for it to provide accelerated depreciation allowances to high-emission industries (thereby encouraging them to invest more heavily in emission intensive activities) while excluding the renewable energy industry from such concessions.

This paper argues that the money currently spent subsidising new investment in mining and airlines should be transferred instead into accelerated depreciation provisions for the renewable energy industry.

Features of an efficient tax system

In the absence of any market failures, the ideal tax system should have a neutral impact on business decisions about where and how to invest. However, given the nature and extent of the externalities associated with greenhouse gas emissions, society has a substantial interest in the timing and quantum of investment in renewable energy. As society is not neutral about the relative level of investment in fossil fuel and renewable sources of power, the tax system needs to reflect those societal preferences.

While the discussion below applies to plant used for ‘clean’ renewable energy sources, much of the comment would also apply to ‘cleaner’ energy sources, such as gas, and to carbon sequestration initiatives. However, the latter is still at the experimental stage, ensuring that the main issue would be its treatment under existing research and development provisions.

Renewable energy investments

An important feature of renewable energy is that, compared to fossil-fuel power stations, the running costs are very low. While a small amount of maintenance must be carried out, there are, by definition, no ongoing fuel costs required to power renewable energy sources. On the other hand, the capital costs of renewable energy sources are often very large relative to the capital costs of a conventional power station of the same capacity. That means the economics of alternative energy investment is driven by capital costs, which fall into two categories on an operational power plant. First is the **depreciation expense;** second is the **interest expense**. Those two capital costs are discussed below.

Depreciation expense

Depreciation refers to the rate at which a long-lived asset loses value. When a firm spends $1 billion on a new factory that is expected to last 20 years, a component of that $1 billion is assumed to be ‘consumed’ or ‘used up’ each year. The Australian Taxation Office (ATO) provides ‘depreciation schedules’ for a wide range of assets, which help firms to determine the amount of depreciation they can claim as a business expense in each year. That is, the more depreciation that can be claimed in a year, the smaller the firm’s profit will be and, consequently, the smaller its tax bill will be.

While the total value of the depreciation deductions will, over the life of the asset, be equal to the price of the asset, firms would prefer to claim larger amounts of depreciation in the early years of an investment as that means their after-tax profits are greater in the early years. Accelerated depreciation refers to the situation where the law allows firms to calculate depreciation for an asset over a time period that is shorter than the actual life of the asset. For example, if the $1 billion investment described above was expected to last 20 years, the firm would be able claim a deduction of $50 million per year under the straight line depreciation method. However, if accelerated depreciation provisions exist allowing the firm to depreciate the asset over a 10-year period, the allowable deduction increases to $100 million per year, reducing the measured profit on which tax must be paid by $50 million. While the total tax deductions for depreciation remain at $1 billion, under accelerated depreciation all of those deductions can be claimed in the first 10 years of the asset’s life.

Estimating the appropriate rate of depreciation is always problematic, but in an area where technology is changing rapidly there are further complications. A wind turbine, for example, may be expected to last 30 years. However, if the technology is improving rapidly it may mean that a similar plant built in five years’ time would be half the cost. In that case, a plant with today’s technology would be worth only half its present value in five years’ time. That is, rapid technological change can significantly increase the rate of economic depreciation.

When such rapid technological change and price reductions are evident, rapid depreciation is warranted. Consider the case of wind power. Under present ATO depreciation rulings, a wind turbine has an effective life of 20 years while the generator transformer and unit transformer have effective lives of 30 years in a sub-tropical area (25 years in the tropics). With such a long effective life, only a small depreciation allowance can be claimed each year. Under such circumstances, especially when there is a societal goal of increasing investment in renewable energy, there is a strong case for introducing accelerated depreciation for renewable energy assets to reduce the incentive for firms to delay investing in such equipment in the hope it will be cheaper in the future. This is particularly the case when there is potential for increased sales in the short term to actually drive the cost reductions in the medium term.

Another way of looking at this is to note that any potential investor will be tempted to wait five years when the capital cost of the plant will be halved. Hence the project needs to be very lucrative to encourage the investment now rather than in five years' time. The reluctance of the investor to commit in this environment stands in sharp contrast to the aim for a quick introduction of technologies that will free society from the dependence on carbon-based energy sources. When costs are expected to fall significantly over time, the absence of accelerated depreciation provisions will exacerbate a 'first mover disadvantage'. Given the importance of increasing investment in renewable energy, this situation constitutes a significant form of market failure.

A second important aspect of the energy market that may mean alternative energy plant will need to be written off quickly is that there are many competing renewable energies from which to choose but significant difficulty in predicting which is likely to be most viable in the long run. This implies there could be large costs associated with being wrong; that is, investing in a promising technology that does not fulfil its promise. This risk issue is discussed at length in an appendix at the end of this paper.

The implication of the discussion here is that policy makers need to recognise that investors in renewable energy will be facing quite steep and unpredictable changes in the value of their assets—changes that are much larger than the expected physical life of their assets would imply. The introduction of accelerated depreciation provisions would both recognise this problem and help encourage increased investment in renewable energy sources.

Interest expense

The second main capital charge is the **interest expense**. High capital costs bring with them high charges for project finance. The interest expense will be obvious when there is a loan associated with the investment; otherwise the interest expense will be implicit as the 'opportunity cost of capital'. The relevant policy issue is that the market interest rate may be inappropriate for the renewable energy market because it puts up too high a barrier against potential investments.

Energy is very capital intensive and renewable energy even more so. The following table is based on Australian Bureau of Statistics (ABS) figures and attempts to measure the relative labour and capital intensity of the industries. The table shows the value of capital, labour and intermediate inputs used to produce a unit of output in selected industries in the left-hand column. From those figures the value of capital costs as a share of value added can be calculated. Those calculations are given in the right-hand column of Table 1.

Table 1: Capital and labour input costs

	Shares of gross output %			Capital costs as share of value added %
	Capital	Labour	Intermediate inputs	
Agriculture, forestry and fishing	35	21	44	62.5
Mining	52	12	36	81.3
Manufacturing	14	22	64	38.9
Electricity, gas and water	38	17	46	69.1
Construction	10	21	70	32.3
Wholesale trade	17	28	55	37.8
Retail trade	12	39	49	23.5
Accommodation, cafes and restaurants	15	35	50	30.0
Transport and storage	15	24	61	38.5
Communication services	32	20	47	61.5
Finance and insurance	33	34	33	49.3
Cultural and recreational services	14	29	58	32.6

Source: ABS 2007, Experimental Estimates of Industry Multifactor Productivity, Cat No 5260.0.55.001

Table 1 shows that electricity is the second most capital intensive industry (69.1 per cent) following only mining (81.3 per cent).[1] All other industries are significantly less capital intensive than electricity.

Renewable energy is even more capital intensive again. While little detailed public data is available, the annual report of Snowy Hydro Limited shows that capital costs represent about 79 per cent of the value added generated by Snowy Hydro assets.[2] The direct costs of its operations were only 10.6 per cent of revenue while labour costs were an even smaller fraction, although that figure is not separately provided.

More detailed estimates for 2004–05 suggest that capital values per megawatt for generation assets was just under $0.33 million in Queensland, somewhat lower in Victoria at $0.19 and in NSW at $0.23 million.[3] The Snowy Hydro gross assets were $2,438 million at 30 June 2007, implying capital values per megawatt were $0.56 million per megawatt.[4] Renewables tend to have much higher values of capital per megawatt of capacity. One recent report estimated the actual costs and capacity of

[1] The figures here include gas and water with electricity. However, electricity is almost 70 per cent of the total so that the figures in the table should be a fairly good approximation of electricity alone. If anything, the inclusion of gas and water will lower the value added suggested for electricity.

[2] This figure uses the 2005–06 value because 2006–07 was affected by dramatic movements in electricity derivatives and the impact of the drought. Figures are calculated from the Snowy Hydro Limited *Annual Report for the Financial Year Ended 30 June 2007* and refer to the controlled entity 'Snowy Hydro'. The estimate is very conservative since the figures do not separately account for employee expenses so they had to be estimated by adding 'employee benefits expense' and 'direct cost of revenue'. Total value added was the sum of employee expenses, 'depreciation and amortisation expense', 'borrowing costs' plus 'profit before movements in fair value' (and before income tax).

[3] Energy Reform Implementation Group 2007, *Energy Reform: The Way Forward for Australia* http://www.erig.gov.au/assets/documents/erig/ERIG%5Fmain%5Freport20070413181231%2Epdf

[4] The hydro scheme itself is rated at 3756 megawatts while two other gas fired plants have a 620-megawatt capacity.

plants committed to start operations between 2006 and 2008. Those results are summarised in Table 2.

Table 2: Renewable energy sources: Capacity and capital costs

	Capacity	Capital cost $m	Cost per megawatt $m
biomass	68	170	2.5
hydro	92	50	0.5
wave	1	12	12.0
wind	252	532	2.1
total	413	764	1.8

Source: McLennan Magasanik Associates and Centre for Independent Studies 2007, *Increasing Australia's Low Emission Electricity Generation — An analysis of Emissions Trading and a Complementary Measure:* Report prepared for Renewable Energy Generators of Australia, 24 Oct http://www.rega.com.au/Documents/Publications/MMAII-FINAL%20Report.PDF

Table 2 confirms the high capital costs of renewable energy sources and hence the importance of investment and related expenses.

Highly capital intensive industries are, by definition, more exposed to the impact of changes in the cost of finance, that is, the interest rate. An investor needing to borrow to finance a capital project will want to ensure that the cost of borrowing is covered by the income flow expected to be generated by the project. That is, they will need to service the loan. However, even if they put up their own money, a project sponsor is going to require a return commensurate with what might be obtained by lending the money to someone else. Therefore, in a commercial project, the interest rate will put a floor under the returns required by the owner of a power plant.[5]

Some economists may suggest that government should not interfere with the outcomes of the investing and lending markets. The standard argument is as follows:

> If the interest rate is five per cent in real terms and the government (or anyone else) invests in projects that earn only three per cent, the country as a whole will be worse off. The three per cent project will crowd out some of the five per cent projects and so mean a lower level of GDP when the projects are up and running. So, unless there is a very good reason, this approach is contraindicated.

Of course, when the aim is to alter the carbon emissions intensity of the Australian economy, there are indeed very good reasons for advocating investments in renewable energy projects that may not be commercially viable at the current rate of interest.

The business indicator lending rate available from banks is currently around 11.75 per cent.[6] Borrowers are now paying above that depending on how banks rate the risk of their proposals and their ability to finance their loans. This rate is higher than it has been for a number of years. High interest rates have the effect of biasing investment

[5] In practice they may want more than the interest rate in order to insure against project failure, to compensate for tying up their capital and so on.
[6] This figure is based on bank web sites accessed on 25 August 2008.

decisions against long-term investment projects in favour of short-term, quick payback projects. However, society may well want renewable energy projects to pass a lower interest rate hurdle.[7]

These considerations lead to the conclusion that a tax concession for investment in renewable energy would be useful. A scheme that assists investment in renewables seems preferable to one that might subsidise the interest costs (or provide subsidised loans). However, a subsidy for interest expenses would treat businesses differently depending on their different financing arrangements. For example, it would discriminate against companies that choose to self-finance their investments.

The Reserve Bank of Australia (RBA) will use interest rate changes as a tool of macroeconomic policy to influence the quantum of interest-sensitive investments that take place. However, it is not necessarily the case that society's preferred level of investment in renewable energy is consistent with the interest rate at a particular time. An up-front tax concession would reflect the difficulty an investor will have in 'banking' the expectation that electricity prices in the future will include a significant carbon price.

In the US, investors in solar and other renewable energy plant are eligible for the Investment Tax Credit, which gives a 30 per cent tax credit for solar energy property and hybrid solar lighting systems. These arrangements were introduced with the *Energy Tax Incentives Act of 2005*[8] and mean that an investor will only be $70 out of pocket for every $100 invested in eligible plant. However, that reduces the amount that can later be claimed as depreciation on the plant. A similar scheme in Australia would also need to integrate with any changes to accelerated depreciation allowances.

Interestingly, two industry reviews established under the Howard Government, the Mortimer and Goldsworthy reports, recommended grants for projects of national significance. Note too the Ralph Report (*Review of Business Taxation*) from around the same time, which recommended a grant type scheme to replace the loss of accelerated depreciation provisions (which have since been partially restored).[9] Prior to 2001, accelerated depreciation was allowed for all investment in plant and equipment. The Howard Government abolished the general arrangements for accelerated depreciation as part of an overhaul of business taxation, which included a reduction in company tax rates. However, there are many that still apply such as the depreciation applying for transport equipment, including aircraft, trucks, buses and the like, which cost $230 million in 2006–07.[10]

---

[7] In the past the Governor of the RBA has often made the point that he only has one interest rate to apply over the whole of Australia even though the various regions of Australia may have different needs on many occasions. It is equally the case that different industries may have different requirements yet they have to share the same market interest rate.

[8] CCH, 'Credits benefiting the environment' in Financial Planning Toolkit http://www.finance.cch.com/text/c60s15d780.asp. The Investment Tax Credit was due to expire at the end of 2008; however, recent legislation has extended the credits.

[9] D Richardson 1997, 'Industry policy: Mortimer, Goldsworthy and the Economist Intelligence Unit' *Parliamentary Library Current Issues Brief, no 4 1997/98*

[10] This deduction works by setting caps on the effective life of a transport asset that over-ride the ATO's determination of effective life. See Australian Government (2007), *Tax Expenditure Statement* 2007.

The energy market needs a strong nudge from government

If the energy market is characterised by a lack of investment in renewables, it will need a nudge from public policy. Market failure of the types identified above suggests the need for positive government intervention or else the result will be a significant under-investment in socially desirable assets. The tax system is one mechanism for inducing more investment. It is important to note that attempting to offset the high cost of capital through the introduction of accelerated depreciation for renewable energy is not the only means to stimulate investment. On the contrary, the existing Mandatory Renewable Energy Target (MRET) scheme and direct subsidies would complement, rather than substitute for, the introduction of accelerated depreciation because the relatively low rate of corporate tax means that, while significant, the financial benefits from accelerated depreciation are not enormous.

The tax system alone will not be able to address the current low level of investment in renewable energy generation but there is a strong argument for accelerated depreciation arrangements. There are also strong grounds for other elements of policy. According to the Renewable Energy Policy Network, more than 65 countries now have targets for renewable energy and 'are enacting a far-reaching array of policies to meet those goals'.[11]

Conclusion

This paper argues that an efficient tax regime for investments in renewable energy should have a depreciation schedule that reflects the rapid reductions in price that can be expected with this type of investment in the context of rapid technological change. There is also a solid case for an investment tax credit along the lines of the 30 per cent tax credit provided in the US.

These are the results of the examination of the market failures in relation to long-lived investments in renewable technology. The market failures here arise because the technology is evolving rapidly so that the economic depreciation will be much greater than the physical depreciation on the plant. Not only that, but there is substantial risk for investors as there is as yet no clear winner among the various alternative renewable energy sources. Unfortunately for those wishing to see rapid investment in renewable energy, these two factors conspire to create a 'first mover disadvantage'.

Because of the importance of these investments, there is a strong case for measures that are more far-reaching than those involving just the tax system, including a strong nudge from government to help overcome the market inertia evident in this sector.

---

[11] Renewables 2007: Global Status Report at REN21. 2008. 'Renewables 2007 Global Status Report' (Paris: REN21 Secretariat and Washington, DC:Worldwatch Institute). http://www.worldwatch.org/files/pdf/renewables2007.pdf

Appendix: Depreciation rules

Generally, under the Australian income tax system, expenditures on capital items are not a tax deduction. However, capital items are assumed to depreciate and the value of the depreciation is treated as a cost that can be offset against assessable income. The value of the depreciation expense depends on the expected life of the asset. For example, a building is expected to be usable for longer than a computer so that the computer is depreciated much more rapidly than the building.

The ATO publishes a list of assets together with their effective lives.[12] The latter can be used to calculate depreciation deductions. The following table includes just some of the items relevant to the supply of electricity.

Table 3: Effective life of depreciating assts

Asset — *Electricity supply* (*26110 to 26400*)	Life (years)
Hydro turbines and generators	40
Miscellaneous assets	40
On-site switchyard with conventional outdoor switchgear	40
On-site switchyard with gas insulated switchgear	35
Station and auxiliary electrical systems within the power station	40
Wind:	
Generator transformer and unit transformer in sub-tropical area	30
Generator transformer and unit transformer in tropical area	25
Wind turbine	20

Source: ATO, Tax Ruling no 2008/4

The table shows, for example, that the effective life of hydro turbines and generators is 40 years. That figure is then used to calculate depreciation. The ATO allows the taxpayer two choices in applying the effective life of 40 years. Under the ‘prime cost method’ the annual depreciation is taken as the value of the asset divided by 40. One fortieth of the asset, or 2.5 per cent, is deductible. The taxpayer also has the choice of the ‘diminishing value method’. Under that method the taxpayer can divide twice the value of the asset by 40 years so that in the first year five per cent is deductible.[13] However, in the second year the doubling of the value of the asset applies to the written down value, the initial value less five per cent, or in this case 4.75 per cent. The following table summarises the first 10 years of depreciation on a $100,000 investment

[12] Tax Ruling 2008/4 At http://law.ato.gov.au/atolaw/print.htm?DocID=TXR%2FTR20084%2FNAT%2FATO%2F00001&PiT=99991231235958&Life=20080625000001-99991231235959

[13] In 2006, the diminishing value depreciation method allowed depreciation claims of 200 per cent of the written down value of the asset; prior to that it was 150 per cent.

Table 4: Diminishing value method applied to depreciate a $100,000 asset expected to last 40 years

	depreciation	asset value
year 0		100000
year 1	5000	95000
year 2	4750	90250
year 3	4513	85738
year 4	4287	81451
year 5	4073	77378
year 6	3869	73509
year 7	3675	69834
year 8	3492	66342
year 9	3317	63025
year 10	3151	59874

Source: TAI calculations using ATO depreciation rules

Expenditure on any maintenance the asset might require is treated as a tax deduction at the time. Depreciation is really only a notional reduction in the usefulness of the asset concerned.

Many investments are financed by loans from a financial institution. The interest costs of financing the loan will also be a valid tax deduction for the investor.

Uncertainty about the alternative technologies

This subject was considered briefly in discussing depreciation. However the topic warrants further consideration here.

Another problem exists in addition to that associated with the reduction in costs due to improvements in specific technologies. There are a number of competing alternative energy sources on the horizon, some more promising than others and some at a more developed stage than others. Published estimates show the relative costs of some of these [14] but there is a good deal of uncertainty about the estimates. However, uncertainty about the relative cost of the alternatives is even greater if we try to anticipate developments between now and 10 or 20 years hence. The natural inclination of any energy company is to go slowly and wait until everything looks clearer.

Effectively, many companies are being asked to ‘pick winners’ among the competing technologies, forced to make bets on whether wind, solar, carbon capture, geothermal, tidal or some other energy source is going to be the most competitive in the future. Some observers are very critical of governments when they try to pick winners but there should also be some empathy for decision-makers in the private sector whose job is also to pick winners.

All this is taking place in a context where the capital cost of alternative energy sources is two or three times the capital costs of traditional generators. A generator

[14] See for example presentations made by Geodynamics Limited (2008).

that picks the wrong technology risks being stuck with a huge interest bill and capital repayments way above its competitors.

All the generating assets discussed here, whether hydro, wind, tidal or solar, are very capital intensive but once established have very low ongoing costs. In the jargon, their fixed costs are substantial but their marginal costs are very small. That implies that their average costs will also be relatively high and will always be above the marginal costs. But the average costs will be mainly the opportunity cost of capital, which is essentially a notional amount. The cash costs, or out of pocket costs, will remain low.

Take a company that spends $1billion on a renewable energy facility and finances the purchase with a 20-year loan at 15 per cent interest, generating a capital repayment schedule of $13.2 million per month or $158 million per annum.[15] That $158 million puts a firm floor under the income the company must earn to keep solvent. Of course, if the company were to go into liquidation, the bank is most likely to take possession of the asset and sell it to the highest bidder. The value of the asset at auction is likely to reflect market conditions. The plant is likely to continue to operate but that does not provide any comfort for the original owner.

Capital intensive industries face huge dangers in competitive market places. There is always the possibility that competition in the future will reflect marginal cost, which is close to zero with many of the alternative energies. This has been evident in industries such as the airline industry where the marginal cost of the additional passenger is low while the capital cost of the aeroplane and airport infrastructure is high. The high capital cost means the average cost of flying a passenger is going to be much higher than the marginal cost. Once competition breaks out, the competitors will compete as long as they cover their marginal costs, so that their revenue will be adding to profit or reducing losses. However, if they are not covering average costs, their losses will eventually result in some major upheaval as well as losses, which will force some of the operators out of business.

Public policy tends to favour setting up competitive market structures. However, companies are loath to commit to large long-term investments without protecting themselves from the worst of competition. Long-term contracts are one mechanism companies use to protect themselves from the difficulties of competition. For example, mining companies will try to obtain sales contracts before they develop new mines and new energy generators will attempt to secure long-term commitments from their customers. These are some of the means investors have of removing themselves from the potentially destructive forces of competition. Indeed, the very invention of the joint stock company was a means of protecting a group of investors against the possible collapse of large capital intensive investments.

The decision of any one player to delay making an investment is going to be repeated by other players with the result that, in the aggregate, there is no movement towards better sources of energy. The effect of expected technical progress in delaying innovation in other industries has been noted elsewhere. When everyone has an incentive to delay, the industry is characterised by inaction.[16] It has to be emphasised

---

[15] Calculations use the ANZ Bank loan calculator at the ANZ website.
[16] See M Perelman 2006, *Railroading Economics: The Creation of the Free Market Mythology,* Monthly Review Press.

that the inactivity is an outcome of the market at work; if public policy is going to change behaviour in the direction of reduced emissions energy, policy has to work to offset the tendency for inaction.

These considerations have implications for other aspects of public policy towards energy suppliers. Here we note the potentially destructive force of competition and explore the implications for the appropriate taxation arrangements. If the argument is accepted, there is a case for further tax assistance for companies investing in long-term renewable energy sources

It could be argued that almost all investment decisions are subject to various uncertainties with respect to market demand, potential competition and the best technology. There are numerous examples where markets have involved waste through wrong technologies in the early phases and eventually settled down into slothful oligopoly structures in which market players control technological developments. Information technology is the most recent major example. We do not want to argue that the commercial problems in this market are fundamentally different—but the externalities are! The outcomes in the energy market will have a substantial impact on the planet. That was not true in similar industrial developments such as the competition between railroads in the US and UK, Blu-ray versus HD DVD, the fight between Microsoft and Apple, the fight between the two Australian airlines and so on.

McKinsey economists writing in *The McKinsey Quarterly* examined the economics of solar power. In their opinion, the most attractive of the solar technologies for generators is presently concentrated solar thermal power (see box). The economists argue it is attractive because it 'involves centralized electricity generation—much as traditional coal, nuclear, and hydroelectric facilities do—and is today's low-cost solar champion'.[17] However, the McKinsey economists put the view that the long-term prospects are less favourable than other emerging photovoltaic technologies 'so choosing it [concentrated solar power] now is in effect a strategic bet on how quickly relative costs and local subsidy environments will change'.[18] While this was written with the US context in mind, the same considerations apply in Australia.

Concentrated solar thermal power uses mirrors to concentrate sunlight on to fluids, which heat up and then pass through a heat exchanger to generate steam and drive a turbine. Such technologies include parabolic troughs, power towers, linear Fresnel reflectors, dish Stirling systems, and solar chimneys.

Against that the economics of photovoltaic solar power have displayed cost reductions of 20 per cent with each doubling of installed capacity. McKinsey forecasts that between now and 2020, installed capacity will grow from 10 gigawatts today to between 200 and 400 gigawatts. That is a doubling in less than every three years. If the past relationships continue to hold, costs will fall by 62 to 70 per cent on that capacity forecast.[19]

[17] P Lorenz, D Pinner and T Seitz, 'The economics of solar power', *The McKinsey Quarterly*, (Member Edition), 2 August 2008.
[18] Ibid.
[19] Going from 10 to 200 is a doubling 4.32 times. Taking off 20 per cent 4.32 times is equivalent to taking off a cumulative 62 per cent.

It has to be said that the McKinsey view is a very rosy view of the future economics of solar energy. But the rosier the view, the more incentive there is for any company to delay its decision to invest. The McKinsey economists did not pursue those implications

On 1 August, a news story flashed around the world announcing a breakthrough that could lead to a cheap way of storing solar energy for use around the clock and on cloudy days. The aim is to use solar power for electrolysis, turning water into hydrogen and oxygen, which could then be stored and recombined later to produce energy. One of the researchers, Daniel Nocera from MIT, believes that electrolysis could be cheap and efficient within a few years. The full story can be found through many sources.[20]

This story is both good news and bad news for the renewable energy sector. Of course, any breakthrough that hastens the widespread use of clean energy is to be welcomed. However, by twisting the economics in favour of solar it potentially undermines the economics of wind, geothermal, tidal and other energy sources.

The cost of wind-generated power has also been falling quite rapidly as technology has changed. Individual turbines were around 50kW in 1980 with 15 meter rotor diameters and are now up to 5000kW with 124 meter rotor diameters. Figures cited by the OECD indicate that generation costs have fallen from €15.8 to €5.7 between 1981 and 1995 and down further to €3.79 per kWh by 2003.[21] Those figures suggest costs falling by six or seven per cent per annum but it is not clear that these are real inflation-adjusted figures.

According to the US Department of Energy ((US)DoE), the price of wind-generated electricity dropped by nearly 80 per cent from the 1980s to 1998.[22] Depending on starting point in the 1980s, this suggests that costs have fallen by 12 per cent per annum, which is enough to halve costs every five years.[23]

Gains through further lower wind power costs may be limited since the generators themselves seem to become very sophisticated with size and capacity. The larger generators are also going to require much stronger bases, which can be a substantial part of the cost of an installed system. On the other hand the power generated by the turbine increases by the square of the radius of the wind turbine (or length of the blade). Likewise the wind speed tends to increase with the increase in the height above ground level.

Pacific Hydro recently announced that in the five years between receiving approval to build a wind farm near Portland (VIC), improved technology means that now it only has to install half the originally planned number of turbines to generate the same power.[24] The cost implications seem to be commercial in confidence but may not be

[20] Including the ABC web site *Ahead of the Curve*. See "Solar power breakthrough".
[21] D Justus 2005, International Energy Technology Collaboration and Climate Change Mitigation Case Study 5: Wind power integration into electricity systems. OECD http://www.oecd.org/dataoecd/22/37/34878740.pdf
[22] http://www.20percentwind.org/Final_DOE_Executive_Summary.pdf
[23] Taking the full range of the 1980s, the efficiency gains would have been somewhere between nine and 16 per cent per annum depending on whether the starting point is 1981 or 1989.
[24] "Planned wind turbine numbers halved," ABC News On-line 10 September 2008.

realised to the extent that might be expected as there seems to be an unusually high demand for generators at the moment. The (US)DoE projects further rapid demand for turbines well into the future.

Years ago Joseph Schumpeter coined the term ‘creative destruction’ to describe a process that ‘incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one’.[25] The mechanisms vary but include changes in organisation, invention, technology and new sources of supply. A breakthrough in storing solar energy would be a major source of disruption to the power generation industry.

Existing power generators may be stuck with old coal-fired plant but at least, for them, it is cheap and everything else on the horizon is in a state of flux. Existing and potential new competitors will want to wait until the technology is clear rather than take a bet on one particular technology. Paradoxically, the creative destruction on the horizon will induce a period of inactivity prior to the shake-up which is bound to emerge eventually.

[25] JA Schumpeter 1942, *Capitalism, Socialism and Democracy,* NY

References

ABS 2007, Experimental Estimates of Industry Multifactor Productivity, Australian Bureau of Statistics, Canberra, Cat No 5260.0.55.001.

ATO 2008, Tax Ruling, no 2008/4, Australia, at http://law.ato.gov.au/atolaw/print.htm?DocID=TXR%2FTR20084%2FNAT%2FATO%2F00001&PiT=99991231235958&Life=20080625000001-99991231235959

Australian CCH, 'Credits benefiting the environment' in Financial Planning Toolkit http://www.finance.cch.com/text/c60s15d780.asp

US Department of Energy, 2008, 20% wind energy by 2030: increasing wind energy's contribution to U.S. electricity supply, at http://www.20percentwind.org/Final_DOE_Executive_Summary.pdf

Energy Reform Implementation Group 2007, *Energy Reform: The Way Forward for Australia*, at http://www.erig.gov.au/assets/documents/erig/ERIG%5Fmain%5Freport20070413181231%2Epdf.

Geodynamics Limited 2008, Industry Fact Sheet at http://www.geodynamics.com.au/IRM/content/report_presentation.html, accessed 22 October 2008.

Justus, D. 2005, International Energy Technology Collaboration and Climate Change Mitigation Case Study 5: Wind power integration into electricity systems. OECD, at http://www.oecd.org/dataoecd/22/37/34878740.pdf

Lorenz, P. Pinner, D. and Seitz, T. 'The economics of solar power', *The McKinsey Quarterly*, (Member Edition), 2 August 2008.

McLennan Magasanik Associates and Centre for Independent Studies 2007, *Increasing Australia's Low Emission Electricity Generation — An analysis of Emissions Trading and a Complementary Measure*, Report prepared for Renewable Energy Generators of Australia, Melbourne, at http://www.rega.com.au/Documents/Publications/MMAII-FINAL%20Report.PDF

Perelman, M. 2006, *Railroading Economics: The Creation of the Free Market Mythology*, Monthly Review Press.

REN21 2008, 'Renewables 2007 Global Status Report', Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute.

Richardson, D. 1997, 'Industry policy: Mortimer, Goldsworthy and the Economist Intelligence Unit' *Parliamentary Library Current Issues Brief*, no 4 1997/98.

Schumpeter, J.A. 1942, *Capitalism, Socialism and Democracy*, NY.

Snowy Hydro Limited 2008, *Annual Report for the Financial Year Ended 30 June 2007*.