

Prof Ross Garnaut's Public Lecture: Energy Security, Reducing Energy Costs and Mitigating Climate Change: Does Finkel Solve the Trilemma?

Hosts:

Faculty of Business and Economics
Melbourne Energy Institute
Australian German Climate and Energy College
Melbourne Sustainable Society Institute

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TRILEMMA LECTURE

The South Australian lights went out on September 16 last year. An extreme weather event—unprecedented in recorded history for its capacity to disrupt human activity in South Australia—damaged 23 pylons on electricity transmission towers. In response, safety controls automatically shut down a majority of the wind turbines in the state and the interconnector with Victoria. The sudden loss of voltage in the system caused a complete shutdown of power supply through the grid.

Australian consumers pay plenty to the network companies for back-up services to avoid black-outs or to bring the system back to life quickly if it fails. The “black start” systems that should have brought gas generators quickly to life didn’t work. South Australian consumers pay millions of dollars a year, year after year, to keep diesel generators in place in Port Lincoln. They do this in case this beautiful and productive distant corner of our far-flung national electricity system is cut off by failure of the transmission lines somewhere along the way. The diesel generators didn’t start when they were needed.

South Australians lost access to electricity for several hours—excepting only the small number who had battery systems designed to operate independently of the grid, and the residents of a few places including Kangaroo Island which had independent generators which worked when needed. The residents of the Eyre Peninsula, including the fisherpeople of Port Lincoln with their perishable catches, were without power for several days.

Like World War 1 a century ago, the full severity of the South Australian blackout last Spring had many causes without which it would not have happened.

One cause is that humanity has been slow in heeding the clear conclusions of research on atmospheric physics. Failure to sharply and quickly reduce greenhouse gas emissions leaves us vulnerable to increasing severity of extreme weather events.

Another cause is that policy-makers and the grid rule-maker failed to see the implications for individual regions of uniform national incentives to increase solar and wind generation. Uniform incentives have highly differentiated effects across regions with solar and wind resources of widely different quality. Uniform national incentives encouraged disproportionate responses in South Australia with its superior renewable energy resources.

A third cause is that policy makers and the rulemaker presumed that the grid could be managed in the same old way when large increases in intermittent energy supply were changing the nature of stresses on the grid.

A fourth is that the market operator did not monitor the safety settings on wind turbines to ensure that they were consistent with grid stability in Australia’s new circumstances.

A fifth is that the regulator authorised expenditure on standby generation without ensuring that it would work when it was needed.

Any doubts about the priority of energy security in contemporary Australia were removed by two subsequent episodes, two months after the blackout and then in February this year. A failure on the high voltage transmission line from the lignite generators of the Latrobe Valley to Portland blacked

out a large part of western Victoria for long enough seriously to damage the aluminium smelter. The loss of voltage at the Heywood sub-station north of Portland tripped the interconnector with South Australia again, and many South Australian households lost access to power for a while.

And then a heatwave of rare intensity and dimension covered eastern Australia for several days, increasing use of electricity enough to threaten the balance between power supply and demand. Supply to other facilities in New South Wales was secured only by denying power to the State's largest user, taking the Tomago aluminium smelter in the Hunter Valley to the edge of catastrophic failure. New South Wales Energy Minister Don Harwin commented last week: "There's no better way of understanding the capacities and vulnerabilities of our generators than being in a heatwave", the Minister said. Indeed, were it not for the solid performance of solar, he noted, and other renewables, and the "demand response" from consumers volunteering to reduce the load, the result could have been much worse. "Clean energy performed as forecast", Harwin said. "Thermal generation did not".

The Finkel Review was set up immediately after the South Australian blackout. The Council of Australian Government—Commonwealth Energy Minister Josh Frydenberg and his State and Territory counterparts-- appointed an experienced and able group led by Chief Scientist Alan Finkel to make recommendations to ensure the security and reliability of the Australian energy system as we reduce emissions.

The anxieties over energy security from the events of the Spring and Summer shaped the initial political and media response to the closure in Autumn this year of one of the largest and oldest generators, and distinctively Australia's dirtiest--the Hazelwood power station. As it turned out, the market has been able to handle adjustment to massive withdrawal of generation capacity without any challenge so far to the security and reliability of the system.

The withdrawal of a large amount of supply capacity has compounded the massive upward pressure on prices from the Australian domestic gas crisis and incomparably high network costs and retail margins. Power prices have moved to the centre of national concerns.

Meanwhile, there is strong support within the Australian community for this country to do its fair share in the global effort to limit the damage from human-induced climate change.

We have to deal with an energy policy trilemma: the need to provide energy securely, at the lowest possible prices, with greenhouse gas emissions that are consistent with Australia's obligations in the international climate change mitigation effort.

APPLYING THE THEORY OF ECONOMIC POLICY

Ours is a world-beating trilemma.

Or trifecta. Australia in 2017 is wearing the leader's shirt in the developed world contest for high electricity prices for households (Bruce Mountain says that we have recently put our wheel in front of Denmark).

We are well entrenched as the developed country with by far the highest electricity emissions per person.

It seems to me that in 2017 we are well in front of the rest of the developed world on anxiety about security of energy supply.

We wear the leader's shirt in two of the contests only through an extraordinary increase over the past dozen years in costs and insecurity. And to maintain our comfortable lead in the third, we had to reverse a tendency for electricity emissions per person to fall rapidly by global standards in the years of carbon pricing 2012-4.

Will discussion and acceptance of the Finkel recommendations help us to resolve the trilemma, and escape from the unhappy winners' circle?

The three policy objectives of energy security, low costs and low emissions are potentially in conflict with each other. Energy security in the contemporary world could still be won by holding fast to old synchronous thermal energy and duplicating and strengthening centralised energy infrastructure to withstand more intense extreme weather events. It would be much more expensive energy than it used to be because of higher gas prices, and the need to replace ageing generation assets at a time of higher costs. We would have to forego opportunities for turning our rich renewable energy resources into substantially cheaper energy. And we, the developed country most vulnerable to climate change, would be standing in opposition to the global effort to contain the costs of human-induced climate change.

The conflicts among the objectives are complex, and shifting.

The traditional fossil energy was once cheaper than the alternatives, with coal as baseload and gas for balancing fluctuations in demand. But this is being challenged in Australia by the huge lift in thermal energy prices with internationalisation of fuel markets. It is being challenged as well by the rapid fall in solar and wind energy prices. New build renewable energy in Australia is cheaper than new build coal, and much cheaper than gas. New storage and demand management technologies allow distributed generation and storage to take the peaks off demand for grid as well as generation services, and reduce capital costs of the system as a whole.

The traditional synchronous generation would once have been the most secure and reliable. But the increasing intensity of extreme weather events and cyber insecurity are making the old centralised systems more vulnerable. The new technologies for managing partially decentralised grids is allowing power supply to continue across most of an energy system when extreme weather events have caused part to collapse—as they have with bushfires in southern Australia and floods in Queensland on several occasions in recent years; with Hurricane Sandy in New York and New Jersey a few years ago; and in South Australia last year.

And the reduction of greenhouse gas emissions requires changes in the energy mix and for the grid to be managed in a different way to provide secure energy.

The rapidly changing trade-offs among costs, security and emissions mean that any initial choice of the optimal energy mix is likely soon to be overtaken by events.

In seeking to resolve the trilemma, we can draw on old wisdom from the theory of economic policy. The theory of economic policy says that we should choose one instrument for the promotion of each objective.

We need one instrument or set of instruments to promote each of energy security; lower costs; and reductions in emissions.

ELECTRICAL ENGINEERING AND ENERGY SECURITY

The terms of reference of the Finkel Review were built around energy security. The Review's Final Report provides carefully considered and helpful recommendations on energy security. Together with recommendations for reform on energy system governance—themselves shaped to a considerable extent by requirements for energy security--this is the valuable and enduring contribution of the Finkel Review.

The contested issues are the choice of emissions reduction trajectory for modelling, and the recommendation on a Clean Energy Target (CET).

The Finkel Review's recommendations on energy warrant support whether one favours emissions reductions in line with Australia's interests in effective climate change mitigation, or not. Already the expansion of renewable energy supply, including distributed solar PV in households and businesses has gone and has momentum to go too far for the status quo to serve our interests in energy security.

The recommendations on energy security have the Australian Energy Market Operator ensuring that fast frequency response capacity and inertia are maintained at levels that ensure system security; deciding in 2018 whether and how much reserve generation capacity is necessary to meet stability requirements and the mechanism through which this will be secured; requiring new large-scale solar and wind generators to provide grid stabilisation services to offset their own contributions to instability; and differentiating requirements on solar and wind generators according to the circumstances of the region in which they are operating.

The last of these requirements imposes more severe grid stabilisation demands on solar and wind generators in States that have higher proportions of energy coming from intermittent sources.

The Review also recommends that generators provide three years' notice of closure.

On these and other points related to energy security, the Review draws on engineering modelling undertaken by the Melbourne Energy Institute at this University. The modelling distinguishes between minimum requirements of inertia, and fast response frequency control. The former is most reliably provided by synchronous generators—historically provided by thermal generation and hydro-electricity (to which we can add pumped hydro storage with its similar characteristics). New technologies are emerging to carry part or perhaps eventually all of this load. The MEI work suggests that synchronous energy sources provide about a quarter of the minimum load. But in any case, the analysis suggests that, with judicious management, it will be possible to reach the proportions of renewable energy in the modelled trajectories (up to 64 percent below 2005 levels) with existing technologies and without threatening the stability of the system. The MEI Report notes that on-going research may reduce the minimum requirement of synchronous generation.

The economic modelling of the stability constraints by the Jacobs consultancy, suggests little additional cost of power within the modelled trajectories. This conclusion is drawn on the conservative assumption that the sources of inertia are confined to those available now. Recent

discussion of Australia's pumped hydro storage potential has drawn attention to means of greatly expanding synchronous generation at relatively low cost if this is necessary for grid stability.

Fast frequency services can be provided by synchronous generators or by a range of new technologies, including batteries with suitably designed control systems. With effective management by the market operator, the provision can be secured at low cost.

For the most part, the Review leaves decisions on the detail to the Australian Energy Market Operator, sometimes working with the Australian Energy Market Commission. Coordination is to be provided through a new Energy Security Board, on which they are represented, alongside the Chief Executive Officer of the Australian Energy Regulator.

CLIMATE SCIENCE AND EMISSIONS

The Review Report does not discuss climate science or its implications for Australian emissions reductions. It makes no recommendation on the appropriate rate of reduction of emissions in the electricity sector. It says that the trajectories are matters for Governments. It presents the results of engineering modelling by the Melbourne Energy Institute and economic modelling by the Jacobs consultancy to test the implications for energy security and energy prices of pursuing one specified emissions reduction trajectory.

No case is made for the trajectory that is modelled. In one sense, this does not matter, because the Report does not recommend adoption of this trajectory.

But it may matter a great deal, because others have slid into treating a modelling assumption as a recommendation.

The Review recommends that agreement be reached across the Australian Federation on emissions reduction trajectories and a means of achieving them. It argues correctly that this is essential for policy certainty as a basis for investment decisions. That certainty, in turn, is crucial for lowering the supply price of investment in new power generation, and therefore to holding energy costs to the lowest level that is consistent with meeting security and emissions reduction objectives.

Certainty about policy on emissions reduction targets can only be built around shared understanding of the emissions trajectories that serve national interests.

While there is strong community support for Australia doing its fair share in a global effort to combat climate change, there are some Australians in places of political influence and authority who want no such thing.

In the end, a stable policy will have to emerge politically, with one view prevailing over the other in the electoral market place.

The analogy that comes to mind is Medicare. The Whitlam Government introduced Medibank in the face of rabid opposition from the medical profession and the official Opposition parties. It was repealed by the Fraser Government. It was re-established as Medicare by the Hawke Government in 1983. The official Opposition promised to repeal it again in the next four election campaigns. John Howard reversed his commitment to repeal before the 1996 election and won. There has been widely based support for Medicare since then.

For the reasons set out in the Finkel Review, there are large economic advantages in finding an early basis for policy stability. Later in this lecture I will suggest a way of bridging the positions of people who take seriously Australia's interest in effective climate change mitigation, and those who fear that playing Australia's full part will lead to energy insecurity and high energy costs.

The modelling for the Review presumes an emissions reduction trajectory of minus 28% on 2005 levels by 2030, 64 percent by 2050 and one hundred percent by 2070.

The Review notes that Australia has made a commitment to the United Nations to reduce total emissions by 26-28 percent by 2030. Its modelling is based on electricity sector emissions being reduced by 28 percent.

There are questions to be asked about the overall target and about the appropriate electricity sector contribution to it.

The minus 28 percent is part but not the whole of Australia's Paris commitment.

Australia has also committed to doing its fair share in a global effort to hold human-induced temperature increases below 2 degrees Celsius, and as close as possible to 1.5%.

First, the overall target.

The analysis for my 2008 Climate Change Review concluded that Australia's fair share of a 2 degrees effort would be a 90 percent (95 percent per capita) reduction from 2000 levels by 2050. The late and slow start since then requires an early and fast finish.

Other approaches to allocating emissions reduction responsibilities for a 2 degrees target have produced similar or more demanding conclusions. The Australian Climate Change Authority, with statutory responsibilities to advise the Parliament on emissions targets, suggested zero emissions by 2046 in its 2014 Report. Du Pont and others at this University in a recent article in Nature Climate Change suggest a range of 82 to 98% reductions below 2005 levels BY 2050.

None of these assessments refer to the 1.5 degree objective.

The Paris agreement embodied a dynamic approach to emissions reduction targets. The parties to the agreement accepted the end goals on containment of temperature increases. They agreed that each country would pledge medium term targets. It was of the essence of the agreement that the parties would meet periodically to review the pledges, and assess whether they were adequate to the ultimate objectives. The first review under the auspices of the UNFCCC is to take place in 2018. Each country would revise its pledge at that time.

Australia's commitment therefore is not to minus 26-28 percent by 2030. Rather, it is to 26-28 percent, and such additional effort as is committed in future in response to continuing peer and internal review. The Australian Prime Minister noted that Australia would review its pledge in 2017, in preparation for reconsideration of our country playing its full part in the 2018 Conference of the Parties.

I have seen the corrosion of an international commitment in the day to day dynamics of the domestic political process before. My 2008 Review recommended 2020 emissions reduction targets before we knew whether there was going to be any commitment at all by other countries to follow the conclusion of the Kyoto targets in 2012. I recommended that Australian emissions be reduced

unconditionally by 5 percent on 2000 levels by 2020, and by up to 25 percent depending on the action of others. The full recommendation was accepted by the Australian Government in 2009, and supported by the Opposition. The conditions that would trigger the larger reductions were communicated to the United Nations Framework Convention on Climate Change.

I recall a meeting addressed by the then Opposition's Shadow Minister for the Environment in this same Carrillo Gantner Lecture Theatre at the University of Melbourne during the 2013 election campaign. The Shadow Minister confirmed that the Opposition supported the Government's commitment to the United Nations. I asked whether the Opposition's commitment extended over the conditional and unconditional targets. The Shadow Minister confirmed that it covered the conditional as well as the unconditional.

In the event, other countries' actions required an adjustment of the target to somewhere in the range of minus 15 to minus 20 percent. The new Government stuck to the minus 5 percent, and the new Opposition did not contest the slippage.

The Paris agreement has been challenged by the election of President Trump. Syria and Nicaragua are likely soon to be joined by the United States as non-members.

Most substantial countries have responded to the United States announcement on withdrawal by strengthening their determination to make the Paris Agreement work. The avoidance of dangerous climate change is more difficult without the Federal Government of the United States, but not a bit less important for Australia and the world. It is important to preserve the integrity of the international agreement, for the time when the world's strongest state is again able to participate.

This is not a time for weakening our interpretation of the Paris Agreement.

The modelled trajectory of minus 28 percent in the electricity sector is inadequate even if we were to accept that minus 28 percent is appropriate for total emissions.

There has been considerable research in Australia on the relative costs of abatement in electricity and other sectors. My 2008 Review showed that a uniform carbon price would induce larger proportionate emissions reductions in the electricity sector than in the economy as a whole. Modelling by the Treasury and the old Department of Industry and Environment suggests that the optimal rate of emissions reduction in electricity is about three times that in the economy as a whole (Treasury and DIICSRTE, 201X).

Chart 1: Commonwealth Treasury and Industry Department modelling of the relationship between total and electricity emissions reductions.

These studies of the relationship between electricity and total emissions reductions presume similar incentives to abatement across all sectors. From 2012 to 2014 we had incentives across most sectors. The Carbon Farming Initiative in agricultural and pastoral activities was funded by carbon pricing until 2014 and by the Emissions Reduction Fund from 2014 until this financial year. Emissions were expected to fall substantially more rapidly in electricity than other sectors when all sectors received similar incentives. Is it reasonable to expect similar rates of emissions reduction in other sectors in the absence of any abatement incentives at all?

ECONOMICS AND ENERGY PRICES

The prices households and businesses pay for electricity have three components: the wholesale price paid to generators; the costs of access to the poles and wires that move power from the generator to the user; and the margin for retailers. The creation of the National Electricity Market in the 1990s broke the old State Electricity Commissions into the three elements, and corporatised or privatised each. The first element (wholesale) and third (retail) were meant to be competitive. The third (poles and wires), a natural monopoly, was to have regulated investment and prices. Where state ownership continued in the competitive parts of the system (wholesale and retail sales), it was to be guided by the Competition Principles, without Governments subsidising or directing business decisions.

The wholesale market has performed reasonably well in rapidly changing supply and demand conditions. The retail and network segments of the electricity sector have performed poorly.

The Finkel Review makes some sensible suggestions on the need for network planning by a public body, notably the Australian Energy Market Operator, in place of exclusive reliance on private initiatives on investment by monopoly network service providers. It notes that correction of egregious past investments in the networks may require either compulsory or voluntary writedowns. It leaves decisions on these matters to the proposed Energy Security Board. The regulators' role in controlling network costs has been strengthened by the decision of the Commonwealth Government last month to truncate network companies' opportunities to appeal decisions of the Australian Energy Regulator. It has been strengthened as well by a large recent increase in funding.

The Finkel Review notes the problem of monopoly in the retail segment of electricity supply. It leaves action to the Australian Consumer and Competition Commission, which is currently working on these issues.

The Finkel Review confines its detailed modelling and discussion of and recommendations on electricity costs and prices to the wholesale energy market. This has been the least problematic segment of the electricity sector since the reforms of the 1990s.

There is a negative tone to some of the Review's commentary on the wholesale market. Price variability tends to be viewed negatively. Yet price variability in response to changes in electricity supply and demand provides the incentives for users and producers and traders of power to make use of new technologies and business models to facilitate adjustment. There is generally a pessimistic view of the potential for high prices to attract investment in expanding supply capacity. There is generally an open view of the role of direct Government provision of generation capacity to make up for inadequate private investment response. I have never sought to make a case for the use of markets in all seasons. However, much experience informs us that that markets allocate resources effectively where there is genuine competition, supported by public intervention to ensure that external costs and benefits of private activities are taken into account.

I have a more positive view of the wholesale market. It has adjusted smoothly to the absorption of large amounts of intermittent renewable energy. It has provided signals for closure of nine relatively high cost thermal electricity generators over recent years. The currently high wholesale prices are providing huge incentives for new investment in generation capacity all over the national electricity market, and for incentives for storage and demand management to replace expensive gas peaking in balancing intermittent renewables.

The wholesale market has problems, mainly deriving from oligopolistic management of prices in forward markets. These are most severe at the extremities of the National Electricity Market, in SA and Queensland. Problems of oligopoly are best corrected through competition. This is the focus of the current ACCC review.

There have been three recent proposals for direct Government investment in generation: the SA proposal to build a 250 Mw gas generator to serve as an emergency reserve; the Commonwealth's proposal to have Snowy Hydro provide 2000Mw of pumped hydro storage capacity; and the noise from the Australian Mining Industry Council and the Coalition Party rooms about direct Commonwealth investment in a new coal-fired generator.

Serious discussion of these matters amounts to a transformational change in the wholesale power market. The discussion is a material deterrent to private investment in generation and storage. There is a serious risk of damage to the one part of the reformed electricity system that has been serving the interests of Australian users of power.

There is room for debate about whether the old integrated public monopolies would have delivered power at lower cost to Australian users. There is no doubt, however, that a mixture of private and public investment in which non-commercial objectives drive public investment decisions gives us the worst of all worlds.

There was a case for the SA intervention after the national regulatory failures contributed to the recent disruptions. Effective implementation of the Finkel reforms relating to security would diminish that case.

It may be that expansion of pumped hydro capacity in the Snowy Mountains is the most cost effective way of balancing a major expansion of supply of intermittent renewable energy. There are alternatives. There would be large benefits from leaving decisions on Snowy investment to a competitive market. The institutions providing general support to correct market failures affecting supply of low emissions energy—ARENA and the Clean Energy Finance Corporation—could provide assistance even-handedly between Snowy and the alternatives.

Energy security may require separate incentives for provision of reserve capacity. The Finkel Review sensibly leaves that for future assessment by the Australian Energy Market Operator. If this were necessary for energy security, investment in gas generation reserves in South Australia, or pumped hydro storage in the Snowy Mountains, or new coal generation in Queensland could be left to compete in a new market.

The Finkel Review compares the price effects of business as usual, an Emissions Intensity Scheme and a Clean Energy Target. Straightforward carbon pricing—a carbon tax or emissions trading system—was excluded despite its advantages. I am not the person to question the exclusion. The Renewable Energy Target is also excluded.

There are two main differences between the Clean Energy Target and the Emissions Intensity Scheme as defined by Finkel. The Clean Energy Target is applied to retailers of power, and the Emissions Intensity Scheme to generators. The Review notes that application to retailers can use the administrative mechanisms currently in place for the Renewable Energy Target.

The second difference is that the Emissions Intensity Scheme provides incentives systematically for less over more emissions-intensive schemes. It favours black over brown coal; High Efficiency Low Emissions (HELE) coal generation over conventional black coal; gas over High HELE coal; coal or gas generation with carbon capture and storage over naked gas; and renewable energy over coal or gas with carbon capture and storage. The Clean Energy Target provides incentives for less over more emissions-intensive generation only up to a limit of emissions intensity—proposed as 600 kg per Mwh or power. Above that limit, it treats all forms of generation the same.

In this respect, the Clean Energy Target can be seen as a half way house between the Renewable Energy Target and the Emissions Intensity Scheme. The Clean Energy Target, like the Renewable Energy Target, draws no distinction among generating technologies that are more emissions-intensive than the specified “clean energy” threshold. The difference between the Clean Energy Target and the Emissions Intensity Scheme would be small in practice.

I myself would see a lift in the “clean energy” threshold as an improvement for the Clean Energy Target. Raising the threshold (increasing the kg per Mwh) would make the instrument more environmentally and economically efficient. It would favour cleaner over dirtier coal. It would encourage new HELE over old lignite generation, whether or not this had practical significance.

The Finkel Review uses modelling by the Jacobs consultancy to show that, given the emissions reduction target, the Clean Energy Target generates lower wholesale prices than the Emissions Intensity Scheme.

There is no attempt at economic analysis related to these modelling results. We are left to inspect alternative outputs from turning the handle on a black box.

We know a bit about the black box from what is set out in the Jacobs consultancy report, and from the use of the Jacob model, and of similar black boxes, in other contexts.

Business as usual generates higher electricity prices in the Jacobs model for two reasons. First, the supply price of investment in thermal power generation is higher under business as usual because, in the absence of settled policy to encourage low emissions energy, there is greater uncertainty about policies affecting returns on investment.

More powerfully, the absence of policy favouring lower emissions leads to less renewable energy under business as usual. The Jacob model, for good reason, points to lower prices when more renewable energy is generated.

The Jacobs modelling points to lower prices with the Clean Energy Target than the Emissions Intensity Scheme because it treats higher emissions (Victorian lignite) no less favourably than lower emissions coal (NSW and Queensland black coal). The Clean Energy Target therefore leads to higher emissions intensity in coal generation. To achieve the specified reduction of emissions, higher emissions from coal are balanced by higher output of renewable energy. More renewable energy leads to lower prices.

The Finkel Report does not present the results of modelling faster rates of decline in emissions. If it had done so, the Jacobs model, and the most widely used alternatives, would have pointed to even lower wholesale electricity prices.

In the Jacobs modelling, real prices under business as usual remain near current levels, rising a bit in real terms. They fall by a large amount under the Emissions Intensity Scheme, and more under the Clean Energy Target.

Under the Jacobs modelling of the Clean Energy Target, the ratio of renewable energy generation (including rooftop solar) to total energy supplied through the grid (a curious ratio to emphasise) is 42 percent by 2030. The majority of the increase is from large-scale wind and solar driven by the old Renewable Energy Target in the period up to 2022, and from rooftop solar expansion that does not rely on Government incentives (a ratio to grid delivery of 9 percent by 2030). The introduction of the Clean Energy Target is followed by a sharp deceleration of the rate of expansion of large-scale renewable output.

The particular outcomes depend on the detail of cost assumptions. It would be unwise to base big choices on policy on a particular modelling result

It is useful to step away from the black box and to examine some of the economic influences on wholesale price determination.

Generators bid into the Australian wholesale market every 5 minutes. In a uniquely Australian way the prices are actually settled by averaging over half hour periods—thus handicapping technologies that are capable of responding quickly to and therefore removing imbalances between supply and demand. Australia, after all, is the only country whose major horse race is a handicap, with faster horses being required to carry heavier weights. The handicapping of the swift may not matter much for the Melbourne Cup, but it holds back productive balancing of the increase in variable renewable energy in the Australian energy market. Finkel noted the issue of 5 minute versus 30 minute settlement, and said that the regulators should work out whether the arrangements should be changed.

But that is a detail.

Generators bid into the market at their marginal cost. That is near zero for renewable energy—actually negative when the value of Renewable Energy Certificates is taken into account.

Large wind and solar farms bid volumes according to estimates of output. Renewable energy is produced whenever the wind is blowing and the sun shining. The capital costs of the plants are recouped when the average price exceeds the long run average cost of production. There is investment in new capacity when expectations of future average prices are high enough to recoup capital with an adequate rate of return.

Coal generators bid into the market at the cost of coal plus other operating costs. This is very low for Victorian brown coal, and somewhat higher for black coal. Coal generators are kept going if the expected average wholesale price exceeds their operating costs. Some generators may bid into the market at below operating costs to ensure that they can place their output. They rely on balancing from higher prices at other times.

Gas bids into the market at a higher price than coal. Some gas generators use heat that is wasted in primary generation. Such plants have high capital costs and lower operating costs. These tend to be run steadily over fairly long periods if they are run at all. Other gas generators are more flexible. They have lower capital costs and use more energy per unit of electricity output. They are turned on

and off more quickly to take advantage of temporarily high prices. These are peaking plants, well suited to balancing the intermittency of wind and solar. The cost of gas largely determines the operating costs of both kinds of gas generators, and especially the peaking plants. Gas prices have increased three-, four- or fivefold over the past few years.

While each generator bids its marginal cost, the price received is the highest that balances supply and demand.

Coal energy is produced with relatively little variation in output, so long as expectations of future average prices exceed operating costs. New capacity is only built when expectations of future average prices exceed operating and capital costs—conditions that have not been met for over a decade.

Let us look at how these factors determine price in current conditions in South Australia since the closure of the Northern Power station at Port Augusta in May 2016, and in Victoria before and after the closure of the Hazelwood generator on April 1 this year.

South Australia now relies on highly variable generation from wind and solar, a combination of baseload and peaking gas generation, and balancing flows of power over the interconnectors with Victoria. Wind and solar now represent on average over half of the power generated in South Australia.

When the wind blows strongly and the sun shines, or when the wind blows strongly at night when demand is low, nearly all of the power used in South Australia comes from wind and solar. Power prices are then very low. For 12 percent of the year after the closure of Northern, the price of power was less than \$10 per Mwh, often below zero. The average price over this time was minus \$29 per Mwh (volume weighted). You heard correctly. Minus \$29 per Mwh.

Now that the Northern power station has closed, expansion of renewable energy in SA extends the number of hours when renewables set the price at very low levels. It reduces the average price of power without risk that it will cause a price spike by encouraging the departure of a coal generator.

When SA demand exceeds output of baseload gas and renewables, price has to be high enough to attract power over the interconnector from Victoria. This sets the price at the Victorian level (on average about \$110 since the closure of Hazelwood) plus a margin for transmission.

When output of renewables is particularly weak and demand strong, the peaking gas generators have to be attracted into operation. Gas generation costs set prices at these times. In SA in the year after the closure of Hazelwood, these conditions ruled for 35% of the time, when average power prices were \$171 per Mwh.

The average South Australian price over the whole year was \$127 per Mwh (volume-weighted).

Large amounts of power are produced continuously at low cost from lignite in Victoria's Latrobe valley. Occasionally the Latrobe Valley plus renewable energy output exceeds demand and pushes prices to very low levels. Wholesale prices were below \$10 per Mwh for 3 % of the time in the six months prior to the Hazelwood closure,. Such low prices have not appeared at all since the closure of Hazelwood.

For most of the time in Victoria, the state's requirements are more or less met with Latrobe Valley power, with some contribution from renewables and imports over the interconnectors from three states. Gas peaking is required at times of stronger demand. Gas seems to have set the wholesale price of electricity in Victoria for 13 percent of the time in the six months prior to the closure of Hazelwood (average price \$86 per Mwh) and 30 percent of the time since (\$105 per Mwh).

This is a complex system of price determination. Since the closure of Hazelwood, there have frequently been large flows eastwards across the border at times of high renewables generation in SA and relatively strong demand in Victoria. Over the past few sunny and windy days in SA, the flows have mostly been eastwards, reversing only in the morning and evening peaks of demand. The flow of renewable energy eastwards over the border since the closure of Hazelwood has reduced the incidence of extremely low prices in SA and taken the edge off the increase in prices in Victoria.

Charts 2 to 6 illustrate how changes in gas, renewables and coal generation, and in gas prices, can influence average prices.

It takes huge growth in renewable generation capacity to reach the position of South Australia, in which low-cost renewables set the price for a significant part of the time. Once that position has been reached—and subject to the dynamics of trade with neighbouring states—a moderate increase in renewable generation capacity leads to a disproportionately large increase in the number of hours when prices are extremely low and lowers average wholesale prices.

For as long as there are still baseload coal generators operating, lower average prices from expansion of renewables reduces their profitability below what it otherwise would be. What it otherwise would be, of course, is now extraordinarily high, with high gas prices setting electricity prices for a third of the time.

If the fall in prices from expansion of renewable goes far enough in a jurisdiction that still has coal generation, the closure of one plant lifts the whole structure of prices for a while. The downward pressure on prices from expanding renewables then resumes.

Chart 2 illustrates schematically the path of prices over time.

Gas exports from Queensland have been the most important source of upward pressure on wholesale prices in the National Electricity Market over the past 18 months. With gas determining the wholesale price in SA for 35 percent of the time, and gas generation more expensive at the beginning, a threefold increase in the gas price more than doubles the wholesale power price.

Both the gas price increases and the closure of Hazelwood have fed into extraordinary rises in Victorian power prices over the past year. Gas has set the wholesale price in Victoria about 30 percent of the time since the closure of Hazelwood.

Given the downward tendency of renewable energy costs and the likelihood that this will place continuing pressure for closure of ageing coal plants, is the Clean Energy Target, or some alternative means of promoting low emissions energy necessary at all? Is it likely to have any effect at all? Is the debate much ado about nothing?

Some uncertainty about the costs of renewables is introduced by the requirements for large scale solar and wind to pay for stability services. I doubt that that will do much to slow the onward march of renewable power generation. But it may for a while.

It is possible that continued cost reductions would cause the emissions reduction target modelled for the Review to be met without assistance from the CET. If this were to eventuate, the Clean Energy Certificates would have no value, and the Clean Energy Target no role. Expansion of low cost renewable energy in these circumstances would be associated with low wholesale prices.

The possibility has implications for policy choice.

RECONCILING DIVERGENT PERSPECTIVES ON EMISSIONS TRAJECTORIES

Some Australians are reluctant to support emissions reduction goals that would allow us to play our full part in a global effort to meet the Paris objectives out of genuine concern for energy costs and insecurity. Others have ideological objections to modern atmospheric physics, or ideological or vested interests in old ways of supplying energy.

I see a prospect for bridging the differences between those who wish Australia to play its full part in a global effort to meet the Paris objectives, and those who have no objection to doing so if it can be achieved without damaging energy security or raising electricity prices to new levels.

There is no way of building a bridge across to the ideological and vested interests. But people of such mind represent a small proportion of the Australian community, and it must be possible to establish effective policy stability without them.

I suggest that we seek to build support around two alternative trajectories for emissions reduction in electricity, and let the cost of electricity as it emerges over time determine which of them that we follow.

The first could be a Lowest Common Denominator trajectory, embodying a low level of ambition.

The second could be called a Paris Trajectory, embodying a reasonable contribution to the global effort to hold temperature increases below 2 degrees and as close as possible to 1.5 degrees.

I note that in discussing the Finkel Report, we are looking at an emissions reduction trajectory for the electricity sector alone, and not for the economy as a whole. The electricity trajectory will need to fall more rapidly than emissions in the economy as a whole, for reasons explained earlier in the lecture.

We would commence on the Lowest Common Denominator path. Should real wholesale prices fall as we moved along the Lowest Common Denominator trajectory, we would automatically shift to a Paris trajectory.

I would hope that the “Lowest Common Denominator” trajectory for electricity emissions would be stronger than that modelled by Jacobs for the Finkel Review. That should be a matter for wide discussion as we work through the climate change policy review that the Prime Minister has set in train in preparation for the 2018 Conference of the Parties.

The second trajectory would be more closely commensurate with what Australia as a developed country would need to contribute, if we are to give the Paris temperature objectives a good chance of success. A starting point would be the careful work of the Climate Change Authority in its 2014 report. This, too, would need to be the subject of extensive analysis, consultation and debate.

Chart 7 presents two possible trajectories, one being that modelled by Jacobs, and one suggested by the Climate Change Authority as being appropriate for the economy as a whole. They are there for purposes of illustration only.

What level of wholesale electricity price reductions, measured year by year and averaged over the major Australian markets, would trigger a shift from one trajectory to the other?

I suggest that we take the average price for 2017 as a base, and shift to the “Paris” trajectory if and when the accumulated fall in real prices from the base year exceeds one percent per annum. The new arrangements would come into effect in 2021, so we would operate on the “Lowest Common Denominator” trajectory in that year unless the accumulated fall in prices from 2017 until 2020 exceeds three percent in real terms.

It would be the cumulative reduction in prices from the base year that triggers change. There would be arrangements for smoothing transition from one trajectory to the other if these were so large as to be disruptive in some later year.

We would stay on the steeper trajectory to 2050 if the fall in real prices until then had accumulated to one third. Most Australians who worry about increasing prices would take reassurance from that outcome.

Australians who believe that we should play our full part in the global effort on climate change would be uneasy about the risk of our country holding back the global effort if electricity prices do not fall. I share that concern. My answer to myself is that we are holding back the international effort now, and the proposal that I am outlining this evening gives us a chance of catching up.

Let me share my own view on the renewable energy contribution to the price outlook. This, for what it is worth, has grown from a decade of deep involvement in the economics of climate change mitigation, and recently intensive private sector work on renewable energy. In my view, the new energy technologies will be a path to decisive reversal of the relentless and immense increase in electricity prices over the past dozen years. Moving onto a steeper emissions reduction path, with energy security provided by implementation of the Finkel Review through revitalised regulatory agencies, and supported by some variation on the theme of the Clean Energy Target, will drive down wholesale electricity prices, not only to lower levels than they are at present, but to prices that are notably low by global standards.

No other developed country has anything like the renewable energy resource endowment per person that is enjoyed by Australia. If we get our policy right, as the whole world moves towards low emissions energy, we will emerge as the developed country with the lowest electricity costs.

We have an opportunity to be the energy superpower of the low carbon world economy.

RESOLVING THE TRILEMMA.

Back to the theory of economic policy.

We have three objectives: energy security; low prices; and emissions reductions in line with our interests and responsibilities in mitigation of climate change.

We need three sets of instruments, one for each objective.

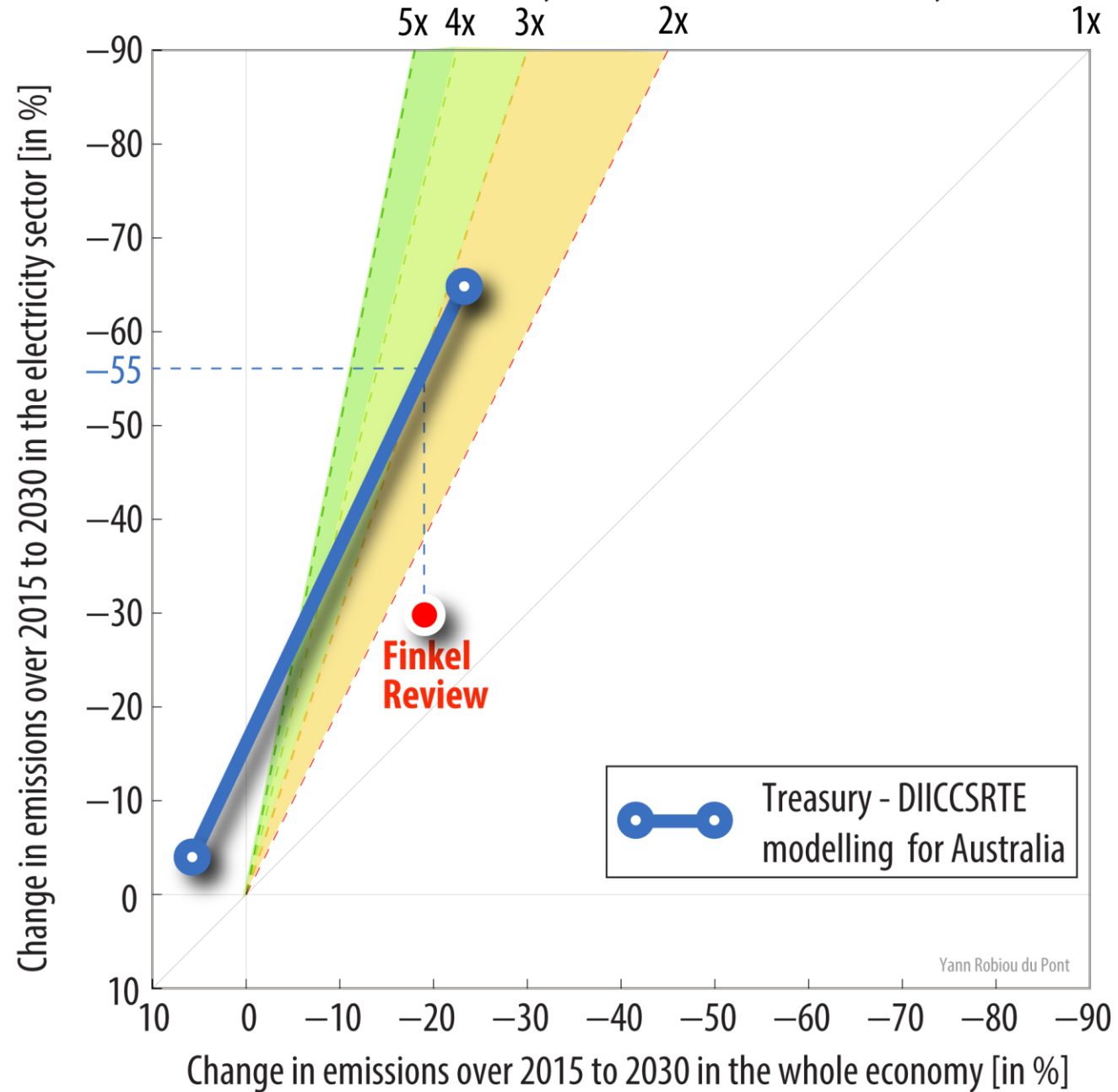
For security, let's accept the Finkel approach, supported by the excellent work of the Melbourne Energy Institute.

On lowering prices, let's embrace the new technologies, provide a more certain policy environment for their application, and accept some variation on the theme of the Clean Energy Target to drive faster expansion of the renewable energy that will force prices down. Let's keep arbitrary interventions of government out of generation, to avoid unnecessary increases in the supply price of private investment. And let's have our regulatory authorities ensure that there is genuine competition in all parts of the wholesale power market.

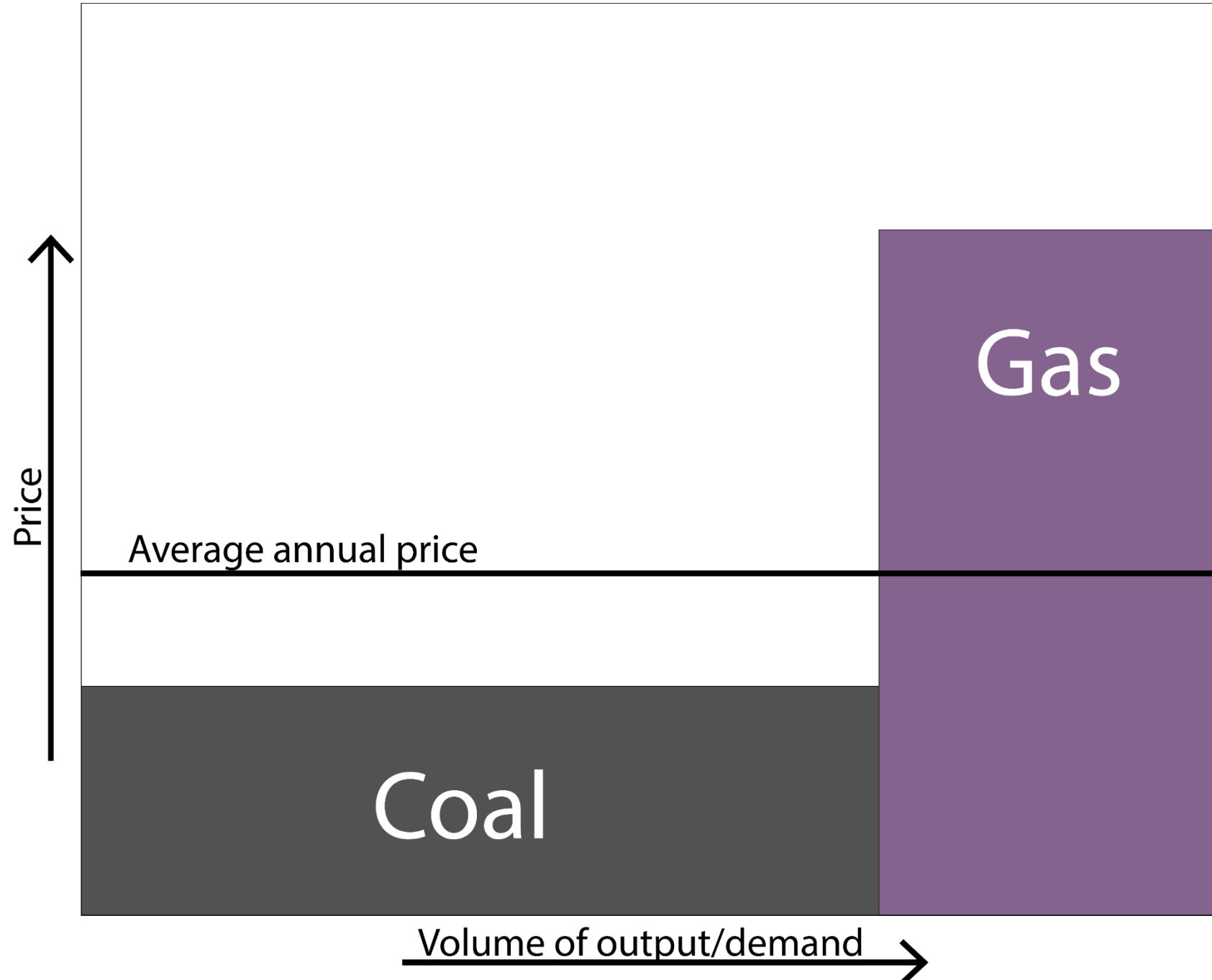
On emissions reduction, let's face up to the facts from climate science and international commitments, and put in place emissions reduction trajectories and policies that give us a chance of contributing positively to global action on climate change.

Finkel has given us the framework and major components for resolution of the trilemma. We can fill in the missing parts through serious discussion of the issues.

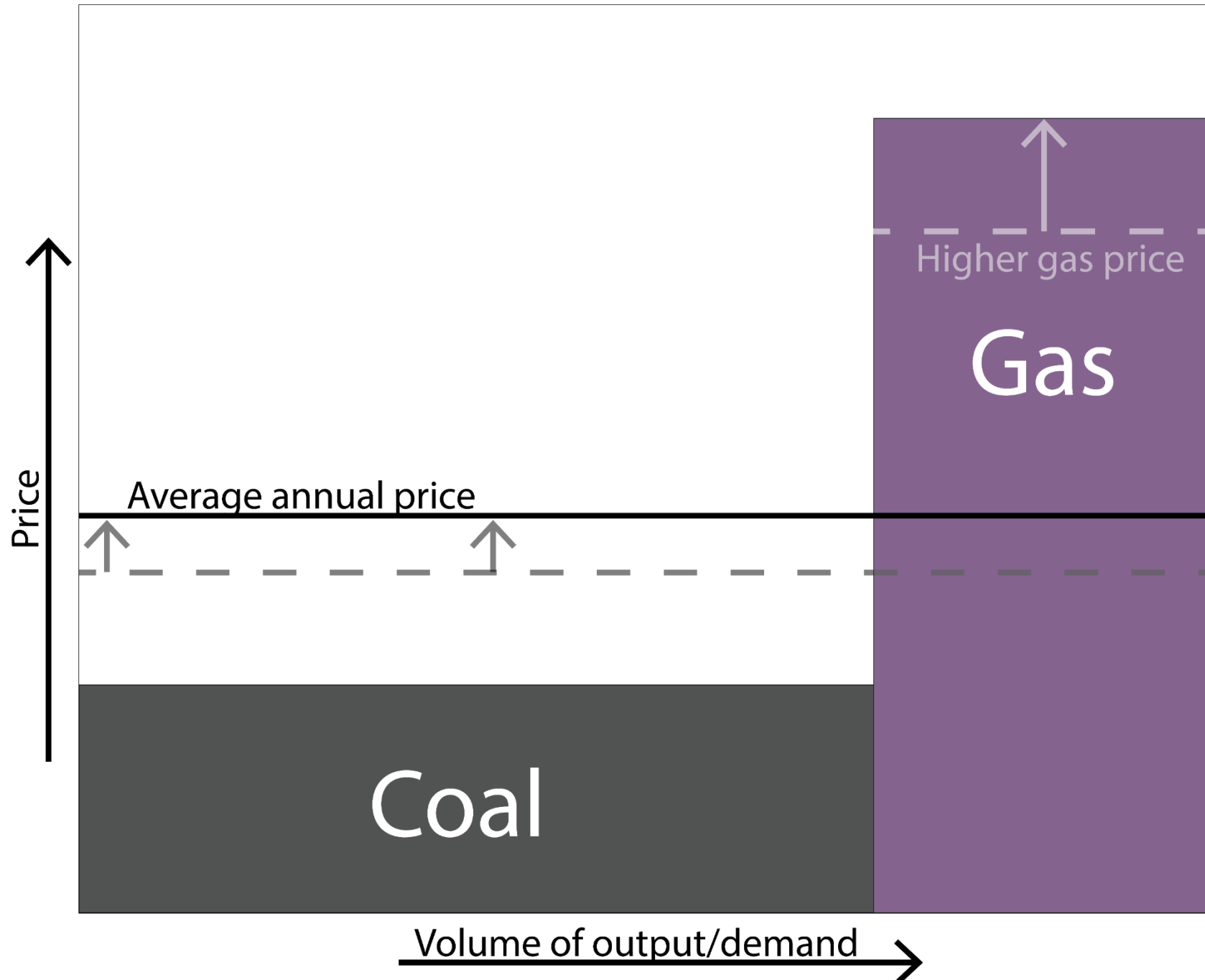
How much stronger emission reductions
in electricity sector versus whole-economy?



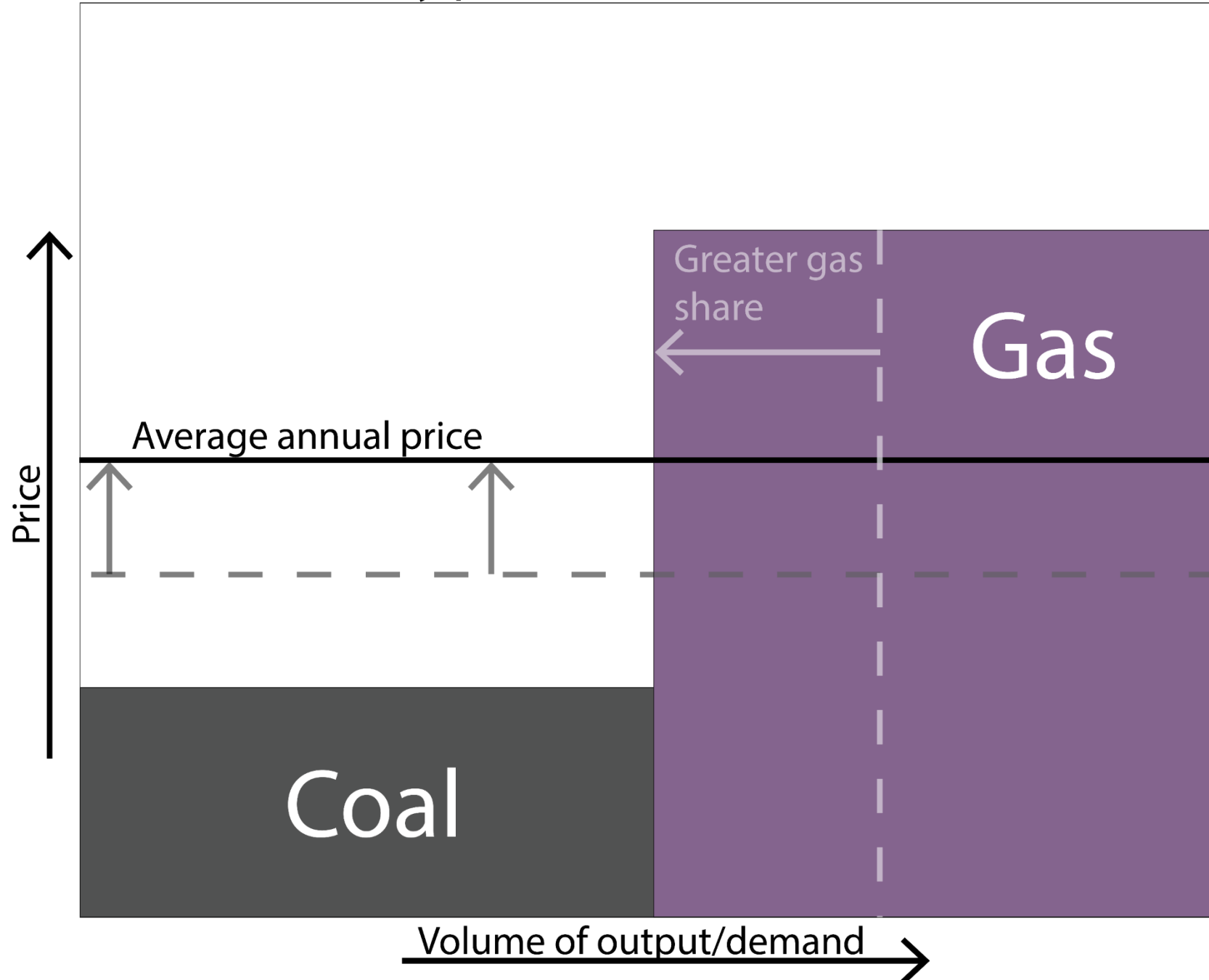
Electricity price formation in Victoria



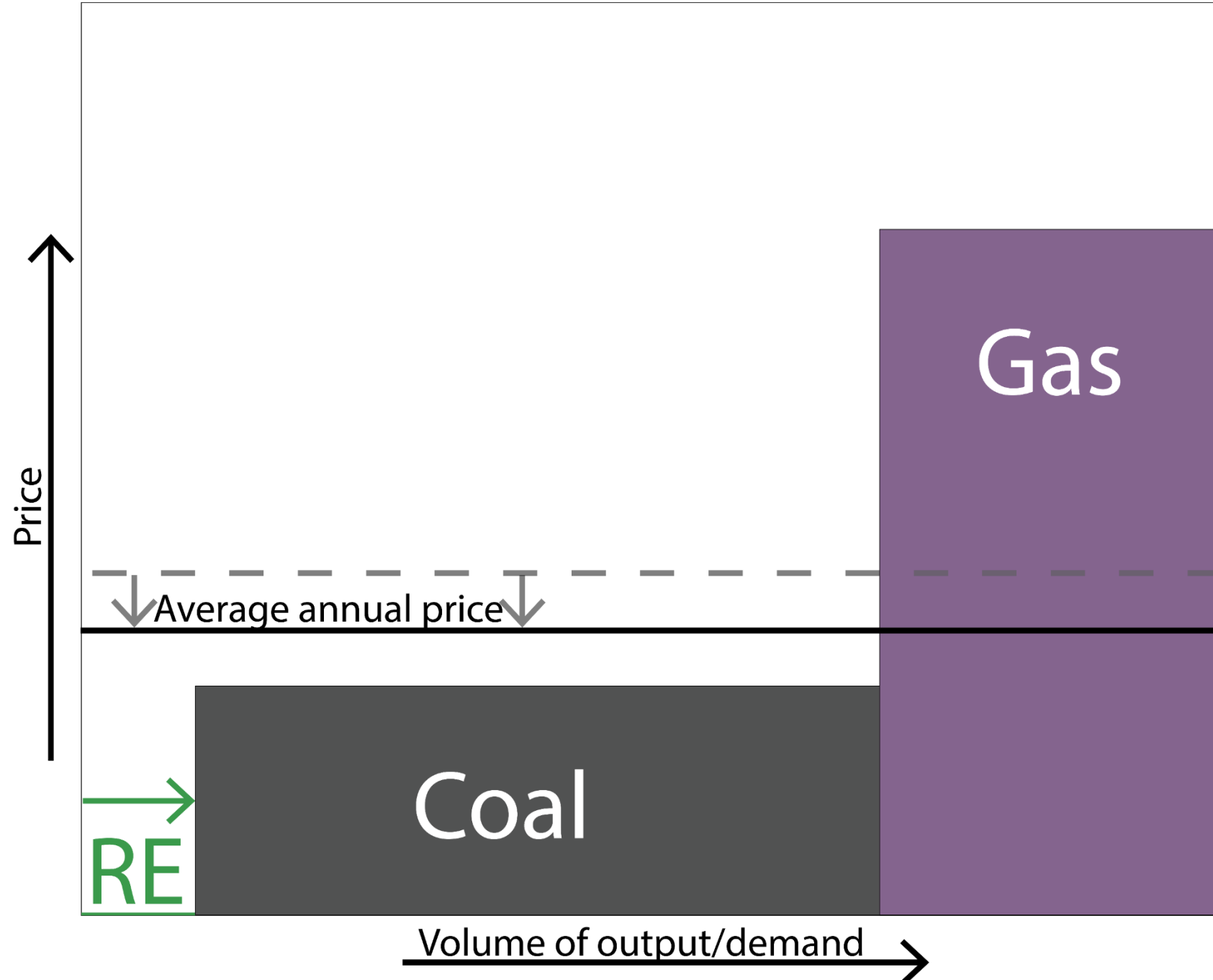
Electricity price formation in Victoria



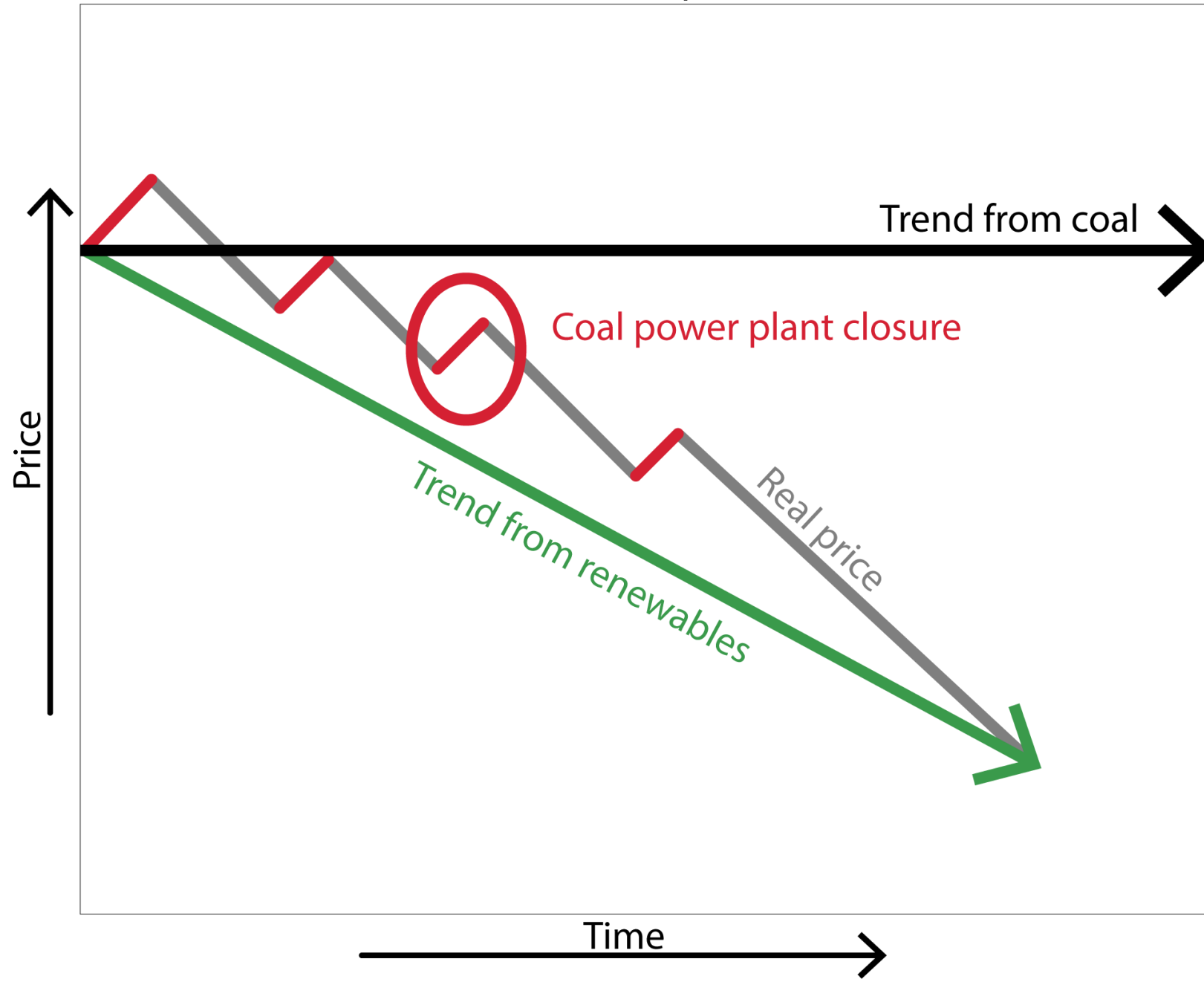
Electricity price formation in Victoria

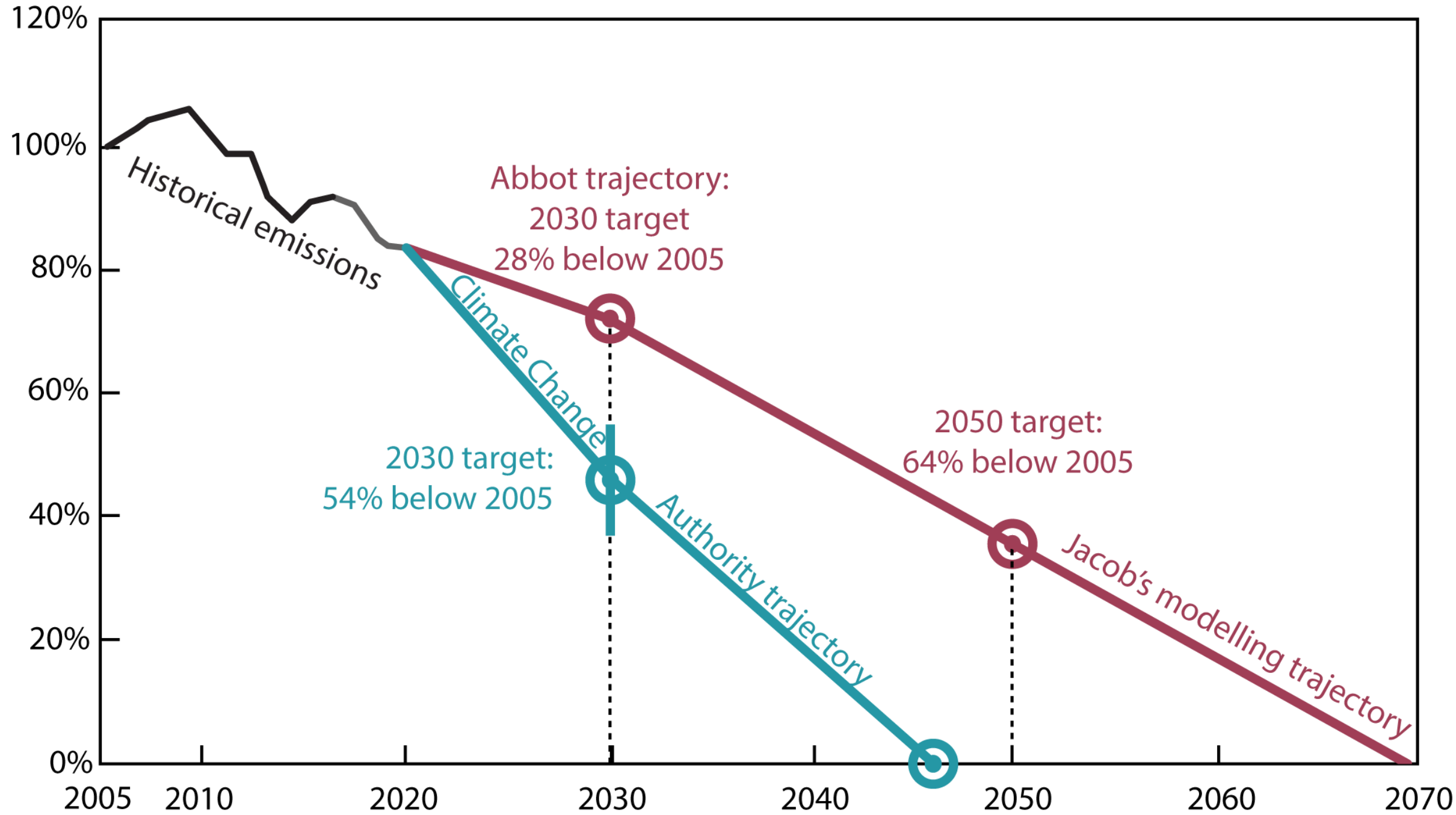


Electricity price formation in South Australia



Schematic profile of prices with expanding renewables
and occasional coal-plant closures





Net-zero emissions in 2046