ACIL ALLEN CONSULTING

REPORT TO
OFFICE OF THE STATE LIBERAL LEADER OF SOUTH AUSTRALIA

5 OCTOBER 2017

SOUTH AUSTRALIAN ELECTRICITY SECTOR

WHOLESALE MARKET PROJECTIONS

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1

INTRODUCTION

ACIL Allen Consulting was engaged by the South Australian Opposition to provide modelling and analysis of the South Australian region of the National Electricity Market (NEM) under a number of scenarios.

This report provides summary results of that analysis. It is structured as follows:

- Chapter 2 describes the methodology we used, which centred around *PowerMark*, our proprietary model of the NEM wholesale spot market
- Chapter 3 describes the scenarios we were asked to model
- Chapter 4 provides results.

2

METHODOLOGY

The analysis in this report was conducted using *PowerMark*, ACIL Allen's proprietary model of the NEM's wholesale spot market.

At its core, *PowerMark* is a simulator that emulates the settlements mechanism of the NEM. *PowerMark* uses a linear program to settle the market, as does the Australian Energy Market Operator's (AEMO) NEM Dispatch Engine in its real time settlement process. *PowerMark* is part of an integrated suite of models including models of the market for Renewable Energy Certificates and the wholesale gas market.

PowerMark is based on a large number of detailed input assumptions. For the most part these are drawn from our understanding of the physical and other properties of generators in the NEM and other relevant sources. ACIL Allen's standard July 2017 reference case assumption set as used in undertaking market projection exercises for clients was not adjusted for this exercise other than to create the scenarios described in chapter 3.

It should be noted that the projections described herein are highly sensitive to input assumptions used, particularly in relation to future energy policy. Alternate scenarios in which different energy policies are in place would be expected to yield different market outcomes.

Similarly, it should be noted that the modelling is based on the assumption that the network infrastructure is available in a 'system normal' state. The storm related events in South Australia in September 2016 illustrate very clearly the ramifications of severe network interruptions. This type of event is not contemplated by the modelling in this report.

A distinctive feature of *PowerMark* is its iteration of generator bidding. *PowerMark* constructs an authentic set of initial offer curves for each unit of generating plant prior to matching demand and determining dispatch through the market clearing rules. Unlike many other models, *PowerMark* encompasses re-bids to allow each major thermal generation portfolio in turn to seek to improve its position — normally to maximise (uncontracted) revenue, given the specified demand and supply balance for the hourly period in question.

PowerMark has been developed over the past 17 years in parallel with the development of the NEM, NEMS (Singapore) and WESM (Philippines). We use the model extensively in simulations and sensitivity analyses conducted on behalf of industry and Government clients.

PowerMark routinely operates at *hourly* price resolution, unlike the NEM spot market which is settled on a half hourly basis. Half hourly modelling is possible, but our experience is that hourly modelling alters the outcomes very little, but simplifies the model run time and analytical task substantially. We rarely use half hourly projections of the wholesale spot price of electricity and have not proposed half hourly projections here. Rather in assignments such as this we routinely assume that the modelled price remains the same for the whole hour. Our experience, and that of our clients, is that this makes little or no practical difference to the results.

To account for the volatility in the wholesale spot market, we have developed the ability for *PowerMark* to provide numerous simulations for a selection of years in the projection period. Each simulation reflects a unique combination of:

- daily weather, hourly demand and wind farm output patterns (to give 46 annual synthetic sets of synthesised hourly demands and wind farm output patterns)
- generator outages, both planned and unplanned to give 11 annual sets of hourly outages. Our approach to creating these outage sets is to:
  - adopt a static planned outage schedule for each generator unit, and assume the planned outages are scheduled during the periods outside of summer
  - randomise unplanned outages based on the frequency with which individual generators have experienced unplanned outages in the past.

Therefore, our approach to developing generator outages accounts for both credible and non-credible events, with non-credible events less likely to occur in the modelling, just as they are in reality.

Using these 'weather years' and 'outage sets', we produced 506 simulations of relevant hourly outcomes for a given year. Those simulations cover a range of foreseeable conditions relating to weather and other stochastic (random) factors known to affect the market outcomes.

This is particularly relevant for projects such as this with a focus on the use of emergency back up generation. This is because emergency generation is (relatively) unlikely to be needed in 'moderate' conditions. To truly understand the contribution of emergency interventions requires projections of a broad range of conditions.

One implication of this is that the outcomes of the modelling in this report must be thought of as ranges rather than point estimates. To illustrate, consider one of the results presented in this report, namely the wholesale spot price of electricity in 2017/18.

Wholesale spot prices in the NEM are determined every half hour by an auction process. Therefore there will actually be 17,520 wholesale spot prices of electricity in South Australia in 2017-18 because there are 17,520 half hours in a year.[1] In our modelling we worked on an hourly basis, so there are 8,760 spot prices for each year.

Further, we model each year 506 times as described above. Therefore the discussion of 2017-18 wholesale spot prices is actually a discussion of approximately 506×8,760≈4.4 million individual projected hourly prices. Obviously these must be summarised to allow the reader to interpret them in a meaningful way.

To summarise those 4.4 million individual price projections, we first calculate the annual average (once for each of the 506 annual simulations). This is routinely done on either a time weighted[2] or a load weighted basis depending on the purpose to which the results will be put. In this report prices are presented on a time weighted basis.

When this is done, there are 506 projections of the annual average wholesale spot price of electricity in South Australia for each year modelled. The differences in these projections reflect differences in the weather conditions that might be experienced (in terms of demand and wind farm output) and in the effect of planned and unplanned outages.

To summarise those 506 projections further this report makes use of cumulative probability density functions, which are similar to the 'duration curves' commonly used in the electricity sector.[3]

These curves are produced simply by ordering the 506 annual averages (or other statistic in some cases) and plotting them over a percentage range. They show, for example, the level of annual average price (or other parameter) that is central in the projections in the sense that half of the 506 simulations yield lower prices and half yield higher prices. This is the median annual price. The simulations can also be used to identify the 10 and 90 per cent *probability of exceedence* levels of the variable being summarised or indeed any other percentile.

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[1] We disregard the additional day in leap years.

[2] Time weighted prices are actually not weighted at all because each individual price represents the same time period, in this case an hour.

[3] The two look the same and can be interpreted in more or less the same way. The key difference is that duration curves are backward looking, used to summarise actual outcomes, such as price, whereas our curves are forward looking.

A worked example of producing and interpreting the cumulative density function for the projected wholesale spot price of electricity in South Australia in 2017-18 is provided below.

The first input is a table of 506 years of 8,760 hourly prices. The full table is too large to reproduce in this report. A small excerpt is provided in Table 2.1 below.

TABLE 2.1 SUBSET OF PROJECTED WHOLESALE SPOT PRICES OF ELECTRICITY IN SOUTH AUSTRALIA IN 2017-18

Period ending	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5	…	Simulation 506
	$/MWh	$/MWh	$/MWh	$/MWh	$/MWh	$/MWh	$/MWh
1/7/17 1:00	$89.16	…	…	…	…	…	…
1/7/17 2:00	$65.09	…	…	…	…	…	…
1/7/17 3:00	$65.09	…	…	…	…	…	…
1/7/17 4:00	$50.59	…	…	…	…	…	…
1/7/17 5:00	$37.22	…	…	…	…	…	…
1/7/17 6:00	$65.09	…	…	…	…	…	…
1/7/17 7:00	$47.97	…	…	…	…	…	…
1/7/17 8:00	$85.44	…	…	…	…	…	…
…	…	…	…	…	…	…	…
1/7/18 0:00							
Annual average	*$100.82*	*$81.44*	*$100.83*	*$110.76*	*$94.20*	…	*$187.04*

SOURCE: ACIL ALLEN POWERMARK MODELLING

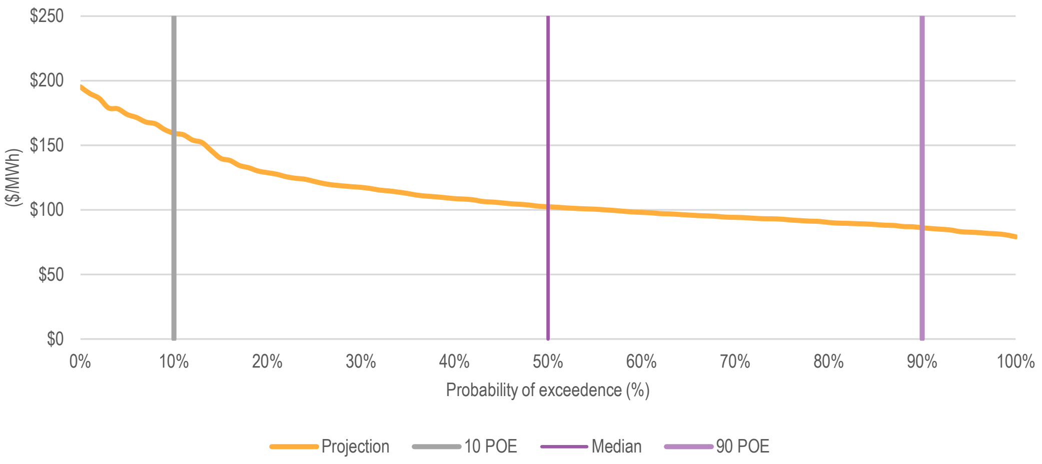
The individual hourly price projections are averaged down the columns in the table, yielding the annual average values in the bottom row, of which there are 506.

Those values are then sorted and plotted to provide Figure 2.1.

The figure can be interpreted as follows:

- the lowest annual average price among the 506 simulations projected here is $79.16/MWh, the rightmost extreme of the orange curve. This is the 100 percentile level, i.e. the projected price was at least this level in 100 per cent of simulations
- the 90 POE price in these simulations is found at the point where the vertical line through 90 per cent intersects with the orange curve, which is at an annual average price of $86.13/MWh. The modelling suggests that there is a 90 per cent chance that the annual average wholesale spot price in 2017-18 suggests will at least $86.13/MWh
- the median, or 50 POE, price in these simulations is found where the vertical line through 50 per cent intersects the orange curve, which is at an annual average price of $102.42/MWh. In plain language, this is the 50:50 level. The modelling suggests that the annual average wholesale spot price in 2017-18 is just as likely to be below $102.42/MWh as above it.
- The 10 POE level is commonly used for planning in the NEM. This is the level which would only be reached under one in ten year conditions. It is found at the point where the vertical line through 10 per cent intersects the orange curve, which is at an annual price of $159.30/MWh. The modelling suggests that there is one chance in ten that the annual average wholesale spot price in 2017-18 will be greater than $159.30/MWh.

FIGURE 2.1 CUMULATIVE DENSITY FUNCTION – 2017-18 PROJECTED ANNUAL AVERAGE WHOLESALE SPOT PRICES – SOUTH AUSTRALIA, POLICY SCENARIO



SOURCE: ACIL ALLEN POWERMARK MODELLING

3

SCENARIOS

The analysis presented in this report comprises two scenarios:

- a *static* scenario, in which no policy changes are made
- a *policy* scenario, which is described below.

The projection period was from 2017-18 to 2023-24. Results are presented for every second financial year during that period.

The static scenario was constructed to reflect the current state of the South Australian NEM region and the NEM more broadly as it was before the release of the South Australian Government's *Our Energy Plan* on 14th March 2017.

The policy scenario reflects the state of the South Australian NEM region as it would be if the South Australian Opposition's policy were to be implemented, noting that this cannot happen until at least March 2018, by which time some of the current Government's policy and contracted commitments would be in place.

Therefore, the static scenario is based on the standard set of modelling assumptions reflected in PowerMark (discussed above), the policy scenario Reference case included the existing fleet of electricity generators in South Australia, and:

- a 100MW/ 129 MWh battery to be available from December 2017
- additional emergency generation as discussed below
- 150 MW solar thermal generation capacity with 8 hours storage from July 2020.
- 40,000 small scale batteries as discussed below
- 650 MW interconnector between South Australia and New South Wales NEM regions (SANI) from July 2021

Neither the static scenario nor the policy scenario included a Clean Energy Target, or other federal emissions abatement mechanism, beyond the existing Renewable Energy Target.

3.1 Emergency generator vs reverse auction

Following the 'black system' event of September 2016 and load shedding on 8 February 2017 the South Australian Government announced its plan to improve the security and reliability of the South Australian electricity grid.

Among other measures that plan included constructing a gas fired power station of 250MW capacity. This would be Government owned and would be operated solely to preserve the power system.

In August 2017 the SA Government changed this aspect of the plan. Its intention is now to lease nine hybrid diesel/ gas turbines with a total capacity of 276 MW and to take an option to later buy those turbines.

The policy scenario includes this additional 276 MW of capacity. We understand the Government's intention to be that these turbines will be operated in such a way as to preserve the power system while having as little impact on the wholesale market as possible. In modelling terms we assumed that the entire 276 MW would be bid into the market at the market price cap at all times.

Part of the objective of the policy scenario was to examine whether the reserve capacity represented by the 276 MW emergency generator could be obtained more cheaply by using a reverse auction approach than through Government ownership. This question is examined in two parts.

First, the modelling results identify the amount of reserve generation that is projected to be required. This does not require changes to the modelling, but to the interpretation. As discussed in chapter 4 below in relation to this question we model the 'buffer' between the generation capacity that is available and that which is required to meet demand.

In a scenario in which the emergency generator is assumed to be in place, it is dispatched as described above. If the available 'minimum supply buffer' remains above 276 MW we conclude that the emergency generator is not used. If the 'buffer' falls below this level, we conclude that the emergency generator is required to prevent outages (this approach is described in more detail below).

In a scenario in which the reverse auction approach is used the results are interpreted differently. Rather than identifying the extent to which the emergency generator would be used, the 'buffer' outcomes are interpreted as the extent to which additional capacity is required.

3.2 Batteries

Another difference between the two scenarios relates to the installation of small scale domestic batteries in addition to those assumed in ACIL Allen's July 2017 Reference case.

In our reference case we model the impact of home energy storage systems by relating installation rates of home energy storage systems to the NPV a household achieves by installing such a system.

We have assumed that the relationship between NPV and installations rates of home energy storage systems will be similar to the relationship between NPV and installation rates of PV systems which has been observed historically.

All existing and future solar installations are assumed to be candidates for the installation of battery storage.

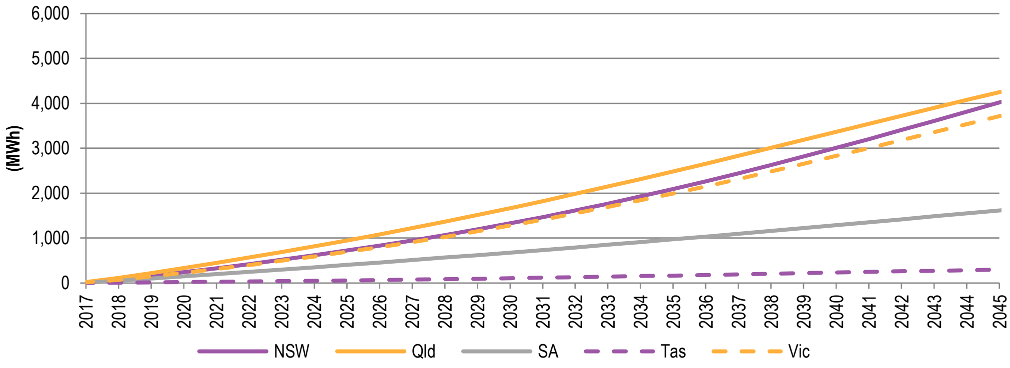
Historically PV system installation rates followed a pattern that is not fully explained by the payoff of such installations alone. Other factors that have led to the uptake of PV systems could include environmental motivations or interest in the technology. This is reflected in a fixed component in our econometric model of PV uptake and results in projected uptake of battery storage even when battery storage installations are associated with negative NPVs. To limit the uptake of battery storage in the early years of our projections we have assumed that no significant number of home energy storage system installations occurred prior to January 2017.

As a starting point for our projections we have assumed a cost of $741 per kWh installed based on the installation cost of a Tesla Powerwall 2.

The economics of battery installations are also affected by the technical characteristics of battery technology. The depth of battery discharge negatively affects battery life – the higher the depth of discharge the shorter the life of the battery. We assume daily cycling of the battery with a depth of discharge of 80% and a lifetime of 10 years (equivalent to 3,650 cycles in its lifetime).

For our projections we have assumed that battery cost decline by six per cent per annum in real terms. Figure 3.1 shows the projected uptake of home energy storage system.

FIGURE 3.1 PROJECTED UPTAKE OF HOME ENERGY STORAGE SYSTEMS – MWH OF CAPACITY INSTALLED



SOURCE: ACIL ALLEN ANALYSIS

In the policy scenario additional units were assumed to be installed due to government subsidy between 2018 and 2021 (5,500 units in 2018 and 11,500 units per year thereafter).

The policy scenario also included the assumption that a 100 MW/ 129 MWh battery is available to the grid in South Australia from December 2017. This reflects announcements surrounding a battery to be provided by Tesla.

3.3 Liddell

As this report was being prepared there was substantial discussion in the press regarding the future of the Liddell power station in the hunter Valley. For clarity, all scenarios include the assumption that this station will close in 2022 in line with AGL's intentions as owner of the power station. We note that AGL has been asked to reconsider those intentions and that its Chief Executive Officer has undertaken to revisit the issue with AGL's board, though as this report was being written the press was reporting that AGL's Chairman had told AGL's Annual General Meeting that there are still no plans to extend the life of the Liddell plant. In this project the modelling was conducted on the basis that Liddell will close.

It should also be noted that this assumption would have only a very small impact on the results presented here given that much of the modelling relates to the period before 2022 when Liddell seems certain to continue operating normally.

4

RESULTS

The results presented here focus on three parameters of the wholesale spot market in the South Australian region of the NEM, each of which is defined below:

1. wholesale spot price of electricity in South Australia in section 4.1
2. minimum available supply buffer in section 4.2
3. unserved energy in section 4.3.

The first parameter, the *wholesale spot price of electricity*, is our projection of the result of the wholesale pool price auction during the projection period. As discussed above, this is simulated hourly for a wide range of weather and other conditions and is presented here as projected annual averages.

To put the wholesale prices shown here in context it may be helpful to note that about 80 per cent of South Australian households use between approximately 1,800 and 8,000 kWh of electricity in a year.[4] This implies that the wholesale cost of supplying electricity to that household is as shown in the bottom two rows of select tables in section 4.1. Note, though, that this should not be confused with their retail bill those customers would receive. The retail bill includes other components such as the cost of network services and the costs incurred by retailers in managing the financial risks inherent in supplying electricity to small customers.

The second modelling outcome, *minimum available supply buffer* presented was devised to address the specific questions asked in this case relating to the use of the emergency generator.

'Supply buffer' is calculated on an hour by hour basis as the difference between demand for electricity and the sum of interconnector flow and available regional generation. It takes account of planned and unplanned outages as well as the extent to which wind farms and solar farms are able to generate due to available wind and solar resource. Given the available fleet of generators in South Australia and that wind farms will typically bid at zero or negative prices in the wholesale spot market, 'supply buffer' is a projection of the extent to which thermal/ scheduled generation is available but not dispatched in any given interval.

Minimum available supply buffer is the smallest supply buffer observed in a single hour of each of the 506 annual simulations. It is therefore the lowest level of undispatched (reserve) thermal capacity projected to be available in South Australia in the projection period.

Minimum available supply buffer is summarised as cumulative (probability) density functions in section 4.2. Note that unlike the illustrative example in chapter 2 and the corresponding curves relating to wholesale spot price of electricity in section 4.1, these curves show the single lowest point to which

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[4] These are the tenth and ninetieth percentile values arising from analysis of recent South Australian data in other recent projects. There are, of course, South Australian households whose usage falls outside these levels, but these provide a guide as to the typical range that might be expected to account for eighty per cent of households.

supply buffer falls whereas the others relate to average prices. Other than this they are conceptually the same.

The third parameter is *unserved energy (USE)*, which is presented in section 4.3.

USE refers to supply interruptions that arise when there is insufficient generation (supply) to meet demand. Supply interruptions in the NEM are infrequent and usually short lived. Of those that do occur, the very large majority are not USE because they are caused by network problems rather than a lack of generation.

There is a link between the minimum available supply buffer results in section 4.2 and USE in section 4.3. The link is that USE occurs in the model whenever there is projected to be insufficient generation to meet projected demand.

Broadly the minimum available supply buffer results can be interpreted by concluding that USE will occur if minimum available supply buffer falls below zero.

However, we emphasise that this does not automatically mean that residential customers would be 'turned off' in these circumstances. There are mechanisms in the market for managing shortfalls. These include demand side participation, which is essentially a process by which large electricity users can agree, in return for compensation, to voluntarily 'turn off' when this is needed to prevent involuntary outages. There are also mechanisms to target shedding of large industrial loads and, thereby, attempt to avoid shedding residential loads.

It is beyond the scope of this project, or of our models, to project whether these other mechanisms would be sufficient to prevent residential load shedding in the circumstances in which we project that USE would occur. We simply note that it is possible, but not certain that residential load would be lost in these circumstances.

In this sense the results here could be considered a prediction of the upper bound of USE.

4.1 Wholesale spot price

The projected wholesale spot price of electricity is a direct output from *PowerMark's* simulation of the bidding activity of generators. As discussed in chapter 2 above, there are 506 scenarios each comprising 8,760 (hourly) simulated wholesale spot prices. For ease of presentation those prices are aggregated as annual average prices and presented here as selected percentiles in Table 4.3 and as cumulative (probability) density functions in Figure 4.3.

4.1.1 Wholesale electricity spot price projection over projection period

The static scenario projection of the wholesale spot price of electricity is summarised in Table 4.1 and Figure 4.1.

At the median level, these show that wholesale prices are projected to decline over the projection period in the static scenario.

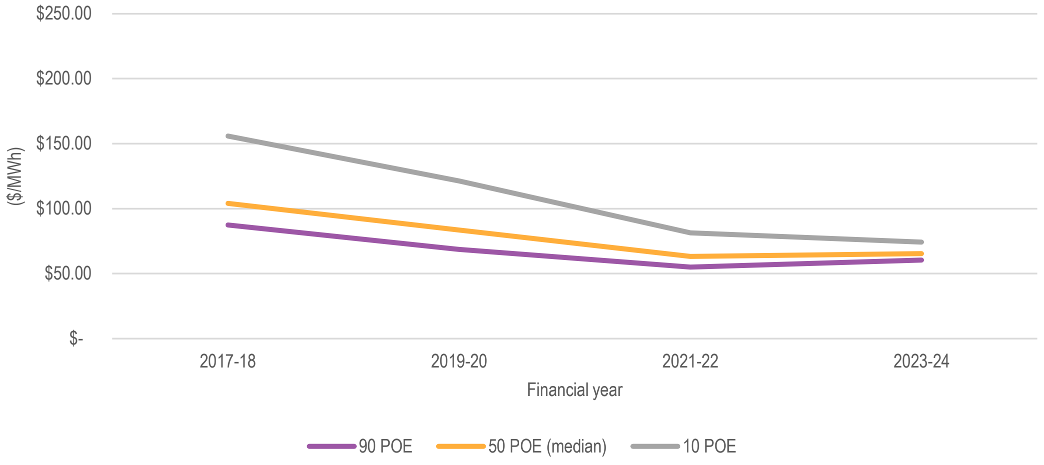
TABLE 4.1 SUMMARY OF PROJECTED WHOLESALE SPOT PRICE – ANNUAL AVERAGE, 2017-18 TO 2023-24, STATIC SCENARIO

Percentile	2017-18	2019-20	2021-22	2023-24
	$/MWh	$/MWh	$/MWh	$/MWh
90 POE	$87.44	$68.65	$55.07	$60.44
50 POE (median)	$104.09	$83.40	$63.13	$65.28
10 POE	$155.85	$121.34	$81.30	$74.22
Wholesale cost – 'small customer' at median price	$187.37	$150.12	$113.63	$117.50
Wholesale cost – 'large customer' at median price	$832.75	$667.21	$505.04	$522.24

SOURCE: ACIL ALLEN POWERMARK MODELLING

Another feature of the projection of wholesale spot price in the static scenario is that the range from 90 to 10 POE is projected to narrow over time. In 2017-18 the projected range is close to $70/MWh whereas in 2023-24 is less than $14/MWh. The projection is for some reduction in price volatility in South Australia. This is partly due to the inclusion of the 150 MW solar thermal project, which is assumed to operate independently of the existing larger portfolios, and hence reducing market concentration as well as increasing supply during peak periods of the day in the South Australian market.

FIGURE 4.1 SUMMARY OF PROJECTED WHOLESALE SPOT PRICE – ANNUAL AVERAGE, 2017-18 TO 2023-24, STATIC SCENARIO – SOUTH AUSTRALIA



SOURCE: ACIL ALLEN POWERMARK MODELLING

The corresponding results for the policy scenario are shown in Table 4.2 and Figure 4.2.

At the median level, these show that wholesale prices are projected to decline over the projection period in the policy scenario. As in the static scenario, these declines are due to substantial increases in generation capacity in the NEM, notably solar and wind plant, particularly in Victoria.

The inclusion of SANI from July 2021 lowers prices in South Australia, relative to the static scenario, by about $15/MWh in 2021-22 in the P50 case. However, in 2023-24, the inclusion of SANI has less impact (although continues to decrease prices relative to the static scenario) due to the operation of the solar thermal project.

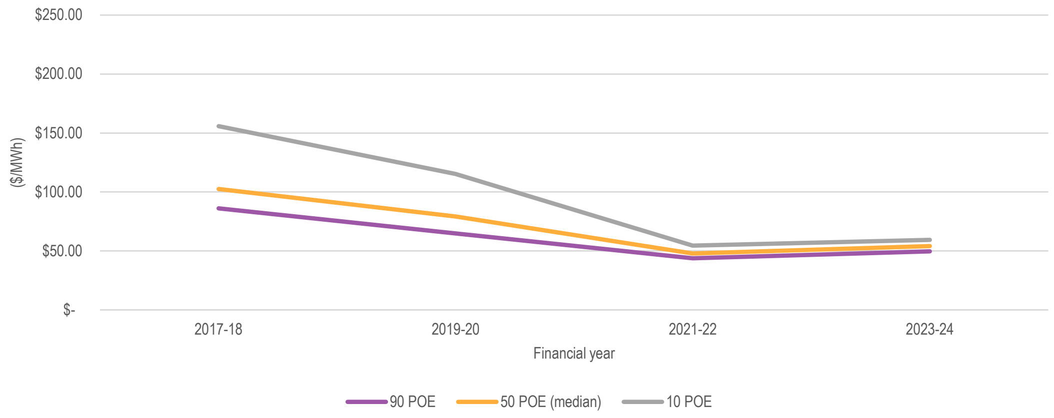
TABLE 4.2 SUMMARY OF PROJECTED WHOLESALE SPOT PRICE – ANNUAL AVERAGE, 2017-18 TO 2023-24, POLICY SCENARIO

Percentile	2017-18	2019-20	2021-22	2023-24
	$/MWh	$/MWh	$/MWh	$/MWh
90 POE	$86.13	$64.88	$43.75	$49.66
50 POE (median)	$102.42	$79.20	$47.87	$54.01
10 POE	$155.85	$115.38	$54.55	$59.27
Wholesale cost – ‘small customer’ at median price	$184.36	$142.56	$86.17	$97.21
Wholesale cost – ‘large customer’ at median price	$819.39	$633.59	$382.96	$432.06

SOURCE: ACIL ALLEN POWERMARK MODELLING

Similar to the static scenario, the range from 90 to 10 POE is projected to narrow over time. In 2017-18 the projected range is more than $70/MWh whereas in 2023-24 it is only about $10/MWh.

FIGURE 4.2 SUMMARY OF PROJECTED WHOLESALE SPOT PRICE – ANNUAL AVERAGE, 2017-18 TO 2023-24, POLICY SCENARIO



SOURCE: ACIL ALLEN POWERMARK MODELLING

4.1.2 Comparison of projected wholesale electricity spot price outcomes between static scenario and policy scenario

Figure 4.3 uses a cumulative probability density function to enable comparison between the wholesale spot price of electricity in SA as projected in the static scenario and policy scenario. This indicates that there is little or no difference in the projected wholesale spot price outcomes as between the two cases in the early years. The wholesale spot price is projected not to be substantially impacted by the policy interventions planned for the next few years.

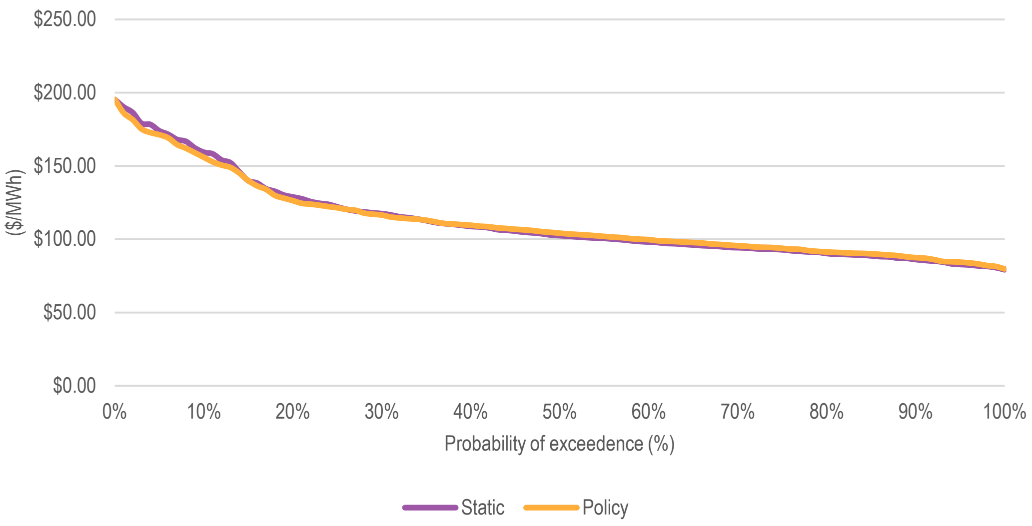
Beyond 2021, with the additional solar thermal generator and interconnector assumed to be in place in the policy scenario, the time weighted price wholesale spot price of electricity in South Australia is projected to be lower than in the static scenario. The magnitude of the difference is depicted by the vertical distance between the two curves and is typically in the range of approximately $10/MWh to approximately $15 or 20/MWh.

It must be remembered, though, that this is a projection of the wholesale spot price alone. Importantly in this context this projection does not reflect changes the cost of the interconnector itself, which would be in the hundreds of millions of dollars, though estimates vary. Under normal settings these costs would ultimately be reflected in retail prices. However, this occurs outside the wholesale spot market, so these costs are not reflected here.

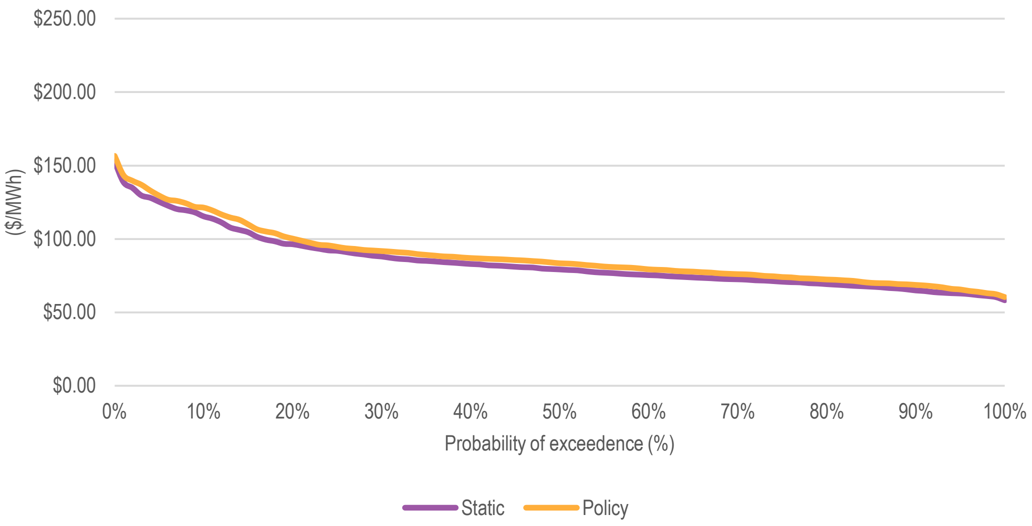
These graphs, along with Figure 4.1 and Figure 4.2 above, show the asymmetric nature of price outcomes in an energy only market. Annual average prices in years of strong weather driven demand and lower wind farm yield (and lower thermal power generator availability) sit much higher above the median annual outcome, than mild year outcomes sit below the median outcome. In the figures above, this is seen in the fact that the distance between the grey 10 POE lines and the orange median lines is greater than that between orange and purple. In the cumulative density functions it is seen by the vertical distance travelled by the curve, which is less to the left of the 50 per cent mark than it is to the right.

FIGURE 4.3 DISTRIBUTION OF PROJECTED ANNUAL AVERAGE TIME WEIGHTED WHOLESALE SPOT PRICE ($/MWH, NOMINAL) – SOUTH AUSTRALIA

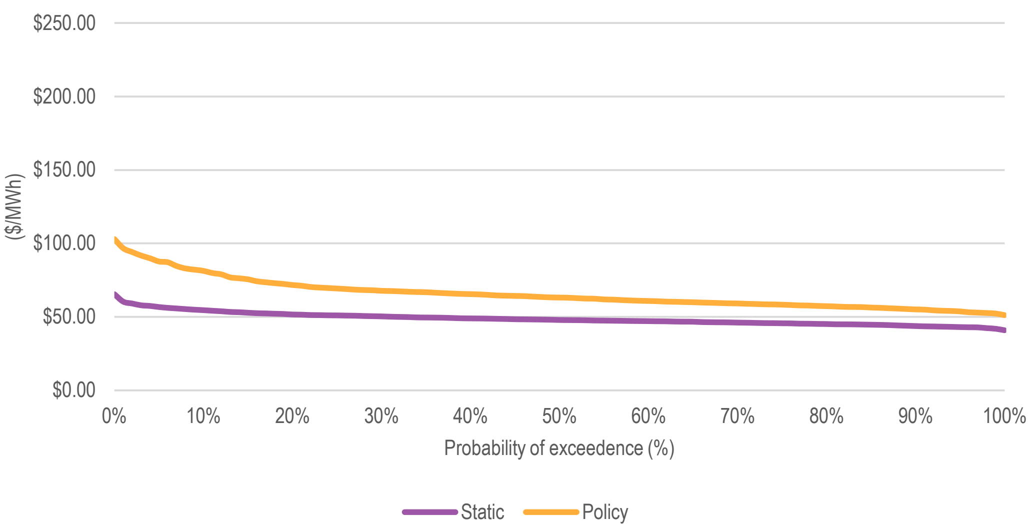
2017-18



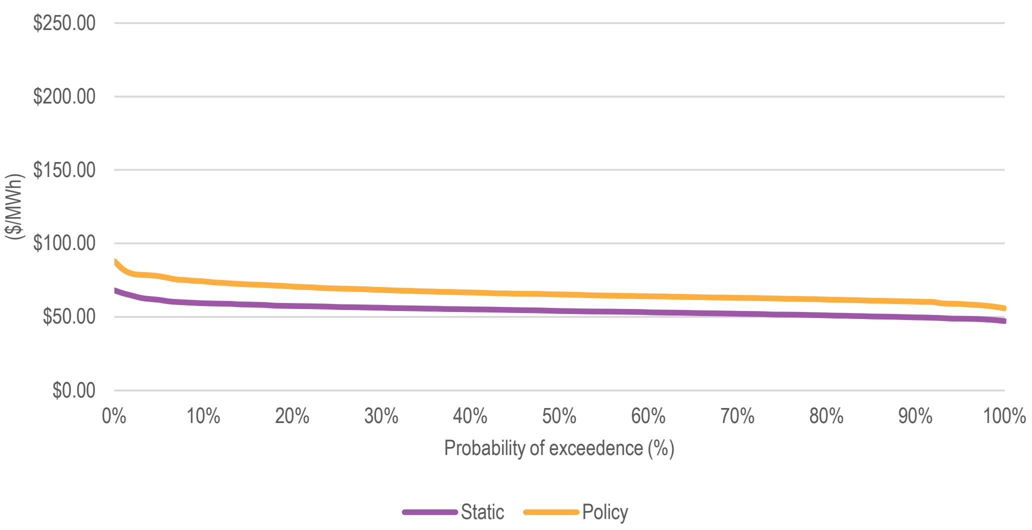
2019-20



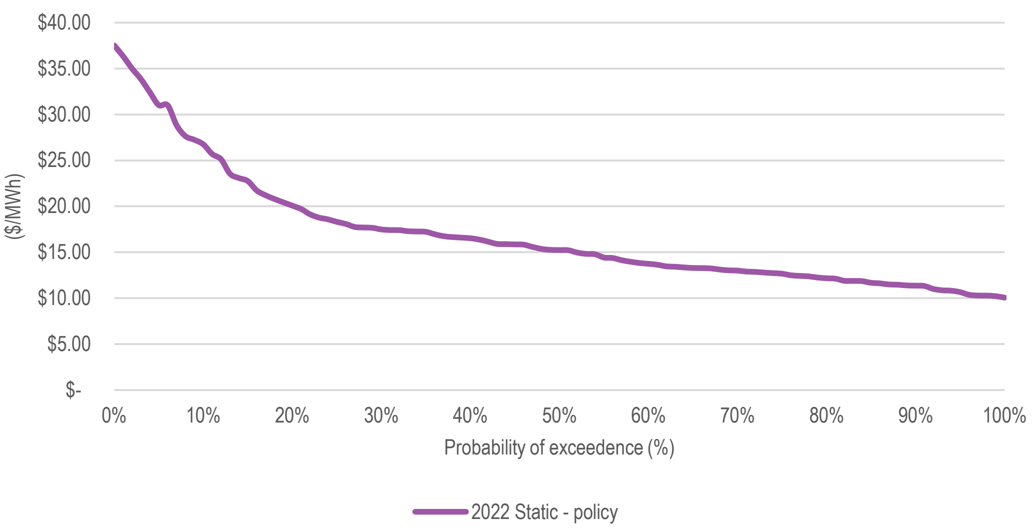
2021-22 (levels)

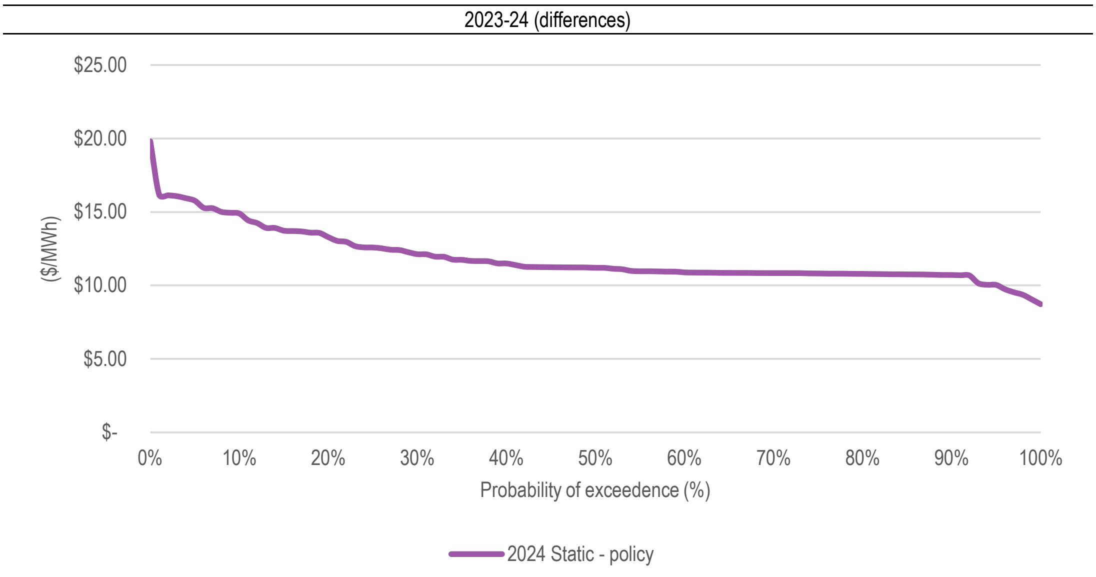


2023-24 (levels)



2021-22 (differences)




2023-24 (differences)

SOURCE: ACIL ALLEN POWERMARK MODELLING

TABLE 4.3 PROJECTED ANNUAL AVERAGE TIME WEIGHTED WHOLESALE SPOT PRICE ($/MWH, NOMINAL) – SOUTH AUSTRALIA, SELECTED PERCENTILES

	10%	25%	50%	75%	90%
2018					
Static	$155.85	$121.44	$104.09	$93.77	$87.44
Policy	$155.85	$121.44	$102.42	$92.79	$86.13
2020					
Static	$121.34	$94.60	$83.40	$74.02	$68.65
Policy	$115.38	$91.92	$79.20	$70.83	$64.88
2022					
Static	$81.30	$69.30	$63.13	$58.29	$55.07
Policy	$54.55	$50.99	$47.87	$45.63	$43.75
2024					
Static	$74.22	$69.34	$65.28	$62.44	$60.44
Policy	$59.27	$56.75	$54.01	$51.57	$49.66

SOURCE: ACIL ALLEN POWERMARK MODELLING

4.2 Minimum available ‘supply buffer’

‘Supply buffer’ is calculated on an hour by hour basis as the difference between demand for electricity and the sum of interconnector flow and available regional generation. It takes account of planned and unplanned outages as well as the extent to which wind farms and solar farms are able to generate due to available wind and solar resource. Given the available fleet of generators in South Australia and that wind farms will typically bid at zero or negative prices in the wholesale spot market, ‘supply buffer’ is a projection of the extent to which thermal/ scheduled generation is available but not dispatched in any given interval.

Minimum available supply buffer is the smallest hourly buffer observed in each of the 506 annual simulations. It is summarised as cumulative (probability) density functions.

In the policy scenario the results provide an indication of how frequently we project that the Government's proposed emergency reserve generation capacity would be used and how much of its 276 MW capacity would be required.

We conducted the modelling of the policy scenario on the basis that the emergency generator is the 'last' generator to be dispatched. Therefore, it would only be dispatched if the maximum available capacity from other generators is insufficient to meet demand, taking account of planned and unplanned outages, the availability of windfarms and interconnector flows.

This means that the emergency generator would be projected to be dispatched whenever minimum available buffer falls below 276 MW and that it would only be used to 'make up' minimum available reserve to 0 MW until other generators are able to make up the shortfall. We assume that the emergency generator would not be used at other times.

Therefore, in the policy scenario, the curves in the figures below are interpreted by identifying the point at which minimum available buffer falls below either:

- 276MW, denoted by the horizontal grey line
- zero MW.

To the extent that projected minimum available supply buffer falls below either of these levels, outages are projected to occur or to be prevented from occurring by the emergency generator. However, as discussed above this does not necessarily mean that supply to residential customers is projected to be disrupted.

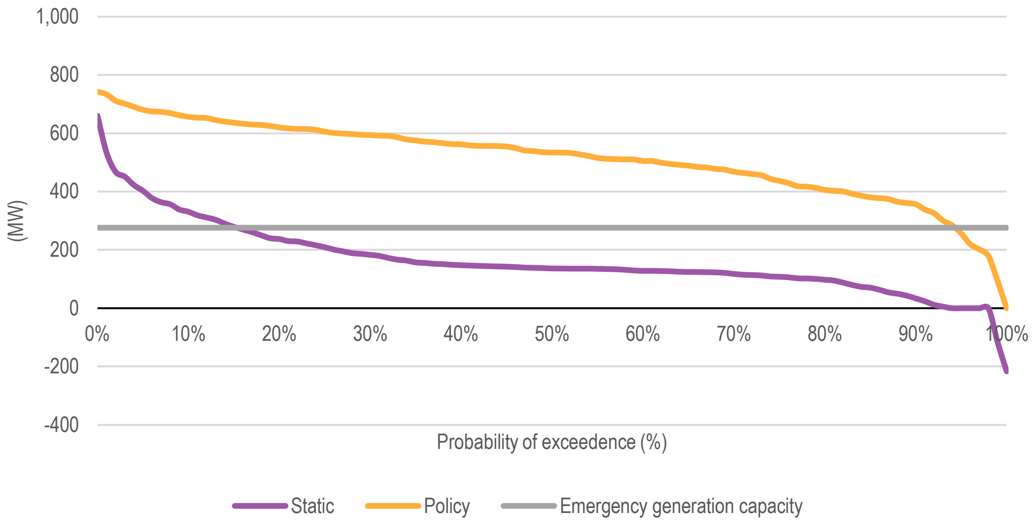
In the later years the emergency generator is assumed to be replaced by a reverse auction mechanism. In this case the results are interpreted differently. In this case circumstances in which the minimum available supply buffer falls below 276 MW indicate a need for reserve capacity beyond that currently available to the market in South Australia.

4.2.1 Minimum available supply buffer projection for 2017-18

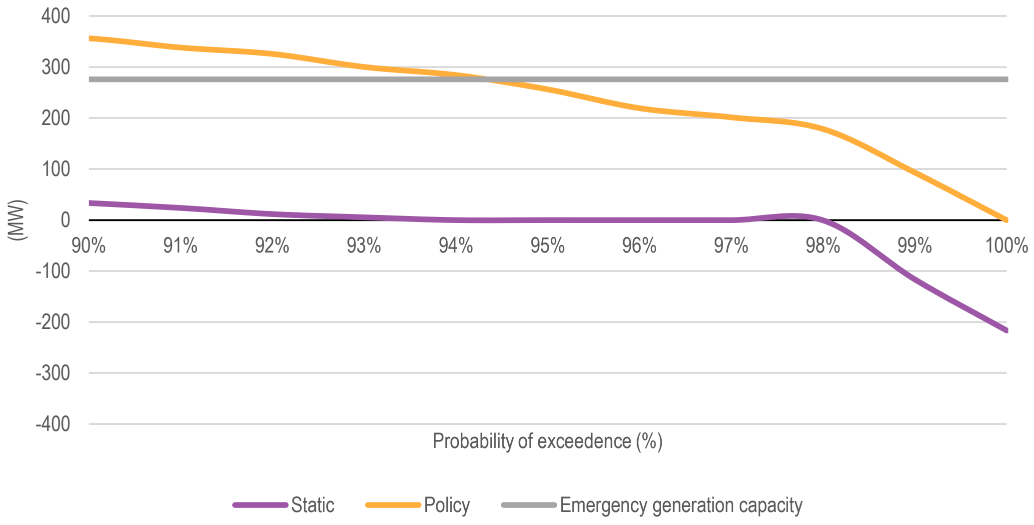
The projected results for 2017-18 are shown in Figure 4.4.

FIGURE 4.4 MINIMUM AVAILABLE SUPPLY BUFFER (MW) – SOUTH AUSTRALIA, 2017-18

Full range of outcomes



Worst ten per cent of outcomes



SOURCE: ACIL ALLEN POWERMARK MODELLING

In 2017-18, the projections indicate approximately a:

- five per cent chance that minimum available supply buffer falls below the capacity of the emergency generator (in the policy scenario, or below zero in the static scenario)
- one per cent chance that minimum available supply buffer falls to zero *even with* the emergency generator in place (or that it falls to -276 MW in the static scenario).

Therefore, the projections indicate that, in the static scenario, USE would occur in 2017-18 if approximately one in twenty year conditions are experienced and other mechanisms such as demand side participation are not sufficient. In the policy scenario USE is projected to occur only in the very unlikely event of one in one hundred year conditions though even in these conditions it may still be prevented by other measures.

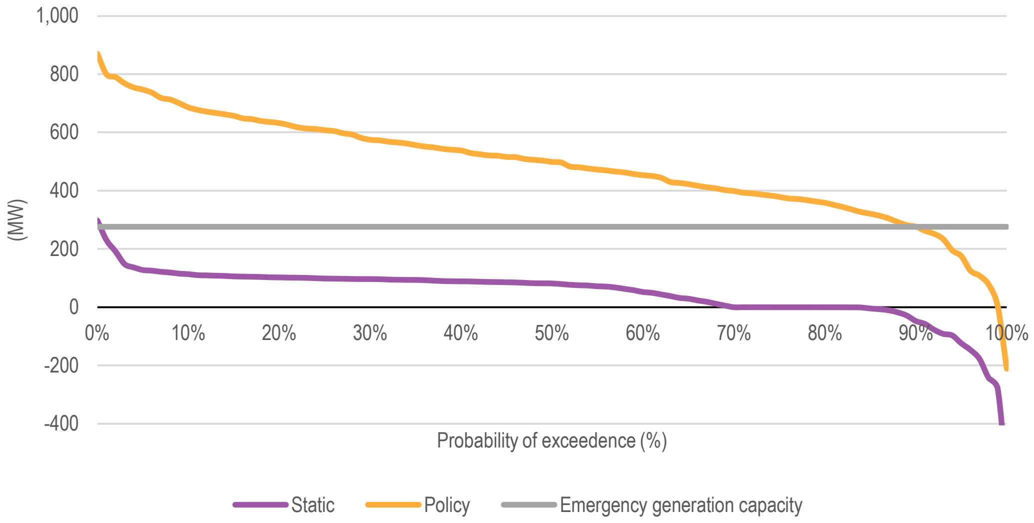
Alternatively, in anything 'milder' than one in twenty year conditions, the projections indicate that the emergency generator will not be used and that it would be sufficient to prevent outages in all but one in one hundred year conditions, in which case the amount of USE is projected to be very small, approximately 0.01 per cent of energy consumed in South Australia in 2017-18.

4.2.2 Minimum available supply buffer projection for 2019-20

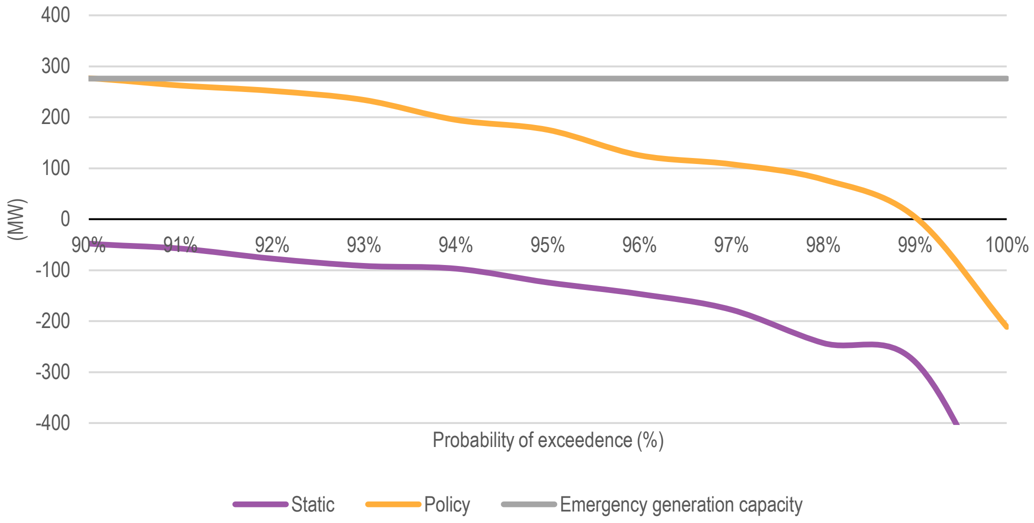
The results for 2019-20 are shown in Figure 4.5.

FIGURE 4.5 MINIMUM AVAILABLE SUPPLY BUFFER (MW) – SOUTH AUSTRALIA, 2019-20

Full range of outcomes



Worst ten per cent of outcomes



SOURCE: ACIL ALLEN POWERMARK MODELLING

The key difference between the 2019-20 projection and that for 2017-18 is the assumed closure of Torrens A to be replaced with peaking plant of a lower capacity at Barker Inlet.

In 2019-20, the projections indicate approximately a:

- ten[5] per cent chance that minimum available supply buffer falls below zero in the static scenario (or below the capacity of the emergency generator in the policy scenario)
- one per cent chance that minimum available supply buffer falls to zero in the policy scenario, *even with* the emergency generator in place.

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[5] The 90 percentile level is 270 MW, whereas the 89 percentile level is 270 MW.

Therefore, the projections indicate that, in the static scenario, USE would occur in 2019-20 if approximately one in ten year conditions are experienced and other mechanisms such as demand side participation are not sufficient. With the emergency generator in place USE is projected to occur only in the very unlikely event of one in one hundred year conditions though even in these conditions it may still be prevented by other measures.

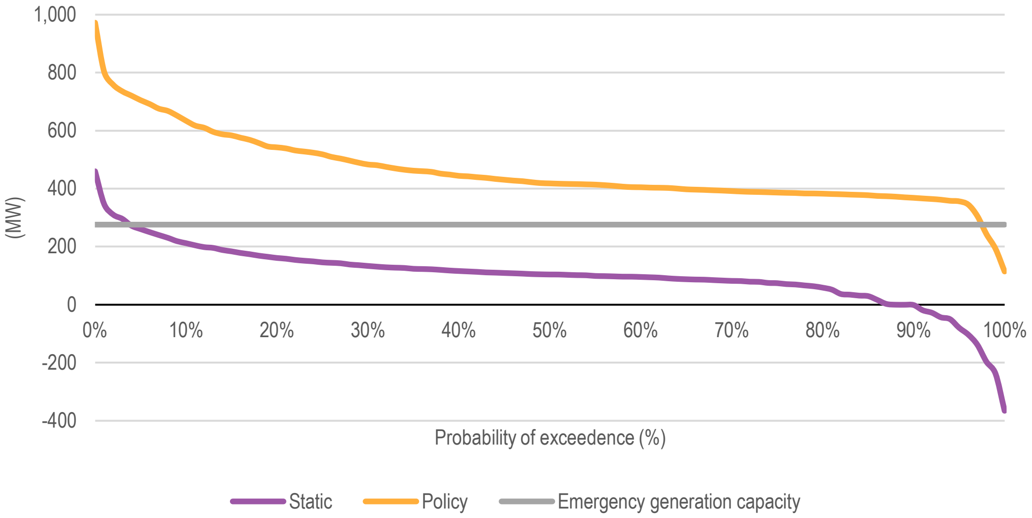
Alternatively, in anything 'milder' than one in ten year conditions, the projections indicate that the emergency generator will not be used. They also indicate that the emergency generator would be sufficient to prevent outages in all but one in one hundred year conditions, in which case the amount of USE is projected to be very small, approximately 0.01 per cent of energy consumed in South Australia in 2019-20 (as is the case for 2017-18).

4.2.3 Minimum available supply buffer projection for 2021-22

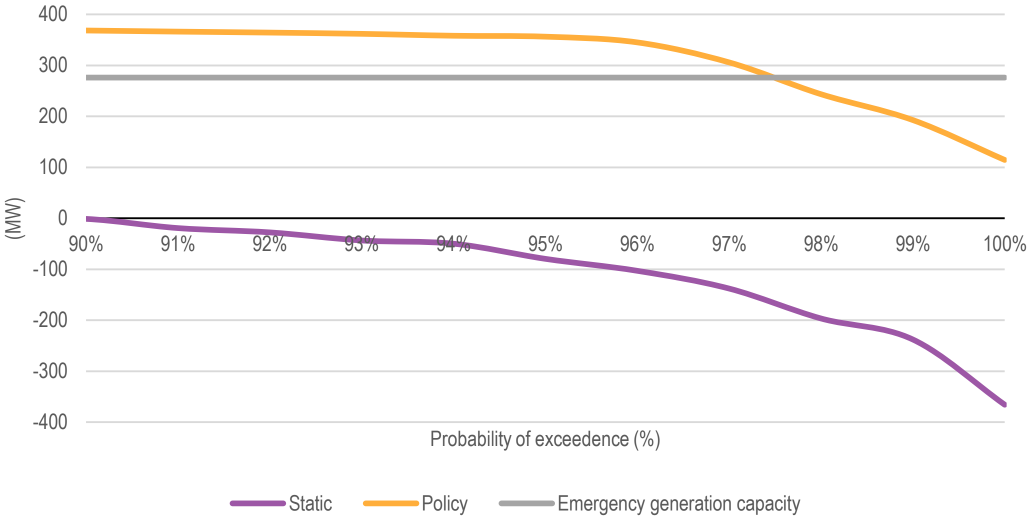
Results for 2021-22 are in Figure 4.6.

FIGURE 4.6 MINIMUM AVAILABLE SUPPLY BUFFER (MW) – SOUTH AUSTRALIA, 2021-22

Full range of outcomes



Worst ten per cent of outcomes



SOURCE: ACIL ALLEN POWERMARK MODELLING

In 2021-22 we do not project a circumstance in the policy scenario in which the minimum available supply buffer will fall to zero. The emergency generator is projected to be used, but never to supply more than 162 MW of power (i.e. minimum available supply buffer is not projected to fall below 114 MW).

On the other hand, in the static case the minimum available supply buffer is projected to fall zero in approximately 10 per cent of cases. However, it is only projected to fall below -276 MW in approximately one in one hundred year conditions.

In 2021-22, the projections indicate that:

- in the static scenario minimum available capacity will:
  - fall below zero in approximately one in ten year conditions
  - fall below -276 MW (i.e. exceed the capacity of the emergency generator) in approximately one in one hundred year conditions
- in the policy scenario, minimum available capacity will:
  - not fall to zero
  - fall to a level that requires the use of either emergency generator or other methods of preventing USE in approximately three per cent of cases.

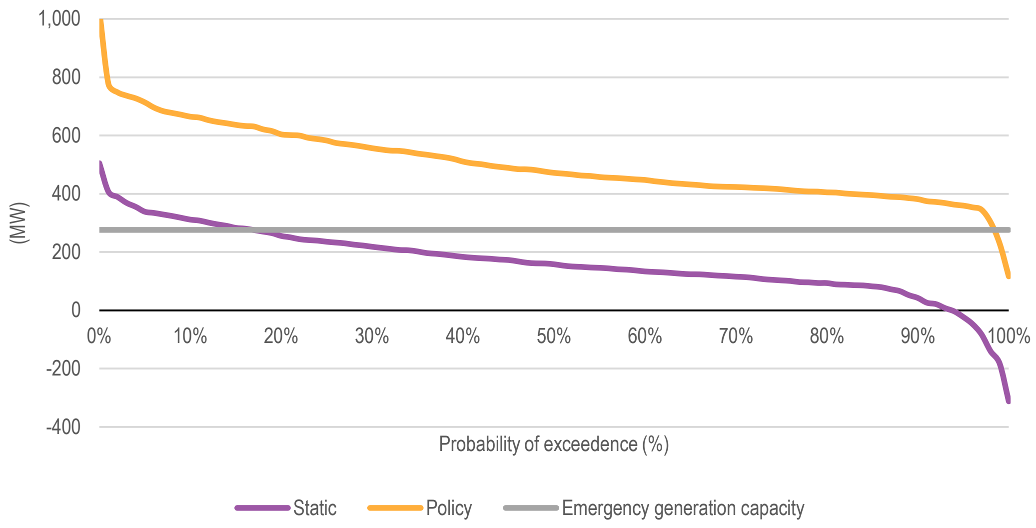
Therefore, the projections indicate that if no steps are taken, USE would occur in 2021-22 if approximately one in ten year conditions are experienced and other mechanisms such as demand side participation are not sufficient. With both the emergency generator and the SANI in place USE is not projected to occur.

4.2.4 Minimum available supply buffer projection for 2023-24

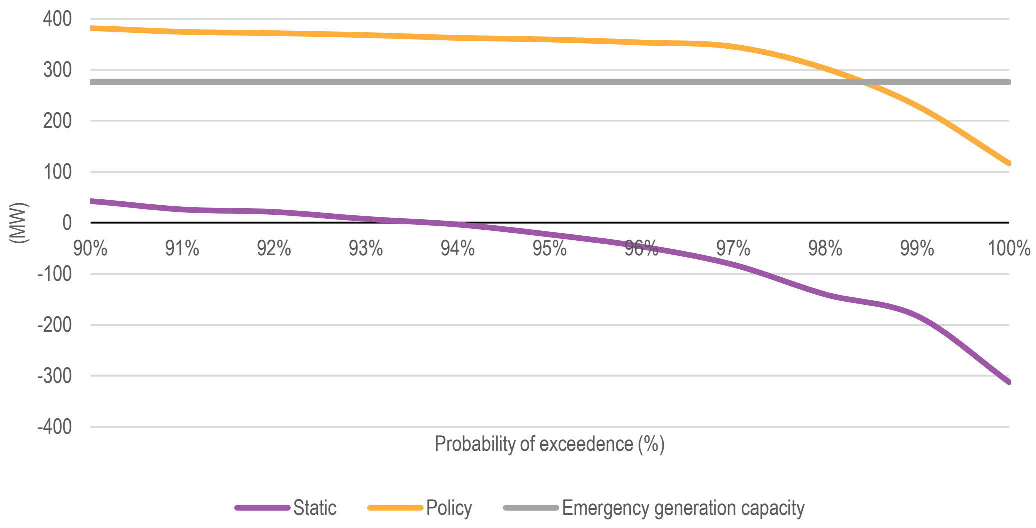
Results for 2023-24 are in Figure 4.6.

FIGURE 4.7 MINIMUM AVAILABLE SUPPLY BUFFER (MW) – SOUTH AUSTRALIA, 2023-24

Full range of outcomes



Worst ten per cent of outcomes



SOURCE: ACIL ALLEN POWERMARK MODELLING

In 2023-24 with the SANI and emergency generation in place we do not project a circumstance in which the minimum available supply buffer will falls to zero. The emergency generator is projected to be used, but never to supply more than 160 MW of power (i.e. minimum available supply buffer is not projected to fall below 116 MW).

On the other hand, in the static scenario, the minimum available supply buffer is projected to fall below zero in around six per cent of cases.

Therefore, the projections indicate that in the static scenario USE would occur in 2023-24 if approximately one in twenty year conditions are experienced and other mechanisms such as demand side participation are not sufficient. In the policy scenario USE is not projected to occur at all, whether the policy is in place of not, though there are circumstances in which the emergency generator is projected to be used.

TABLE 4.4 MINIMUM AVAILABLE SUPPLY BUFFER (MW) – SOUTH AUSTRALIA, SELECTED PERCENTILES

	85%	90%	95%	99%	100%
2017-18					
Static scenario	70	33	-1	-117	-217
Policy scenario	380	356	178	93	0
2019-20					
Static scenario	-4	-48	-243	-280	-595
Policy scenario	321	277	78	4	-211
2021-22					
Static scenario	30	-1	-197	-238	-366
Policy scenario	377	368	243	193	114
2023-24					
Static scenario	82	42	-141	-183	-313
Policy scenario	395	382	302	229	116

SOURCE: ACIL ALLEN POWERMARK MODELLING

4.3 Unserved energy

Figure 4.8 and Table 4.5 provide a summary of the distribution of projected annual USE in South Australia across the simulations. Table 4.6 shows the same outcomes in percentage terms to enable comparison with the NEM reliability standard. This shows that breaches of the standard are projected to occur only in highly unusual circumstances, one or two in one hundred year conditions (highlighted in bold).

Outcomes are only shown above the 85th percentile (i.e. the 'worst' fifteen percent of outcomes).

The broad summary is that the modelling indicates that it is unlikely that USE will occur at all in the projection period. It would be more likely, though still very unlikely, to occur in the static scenario.

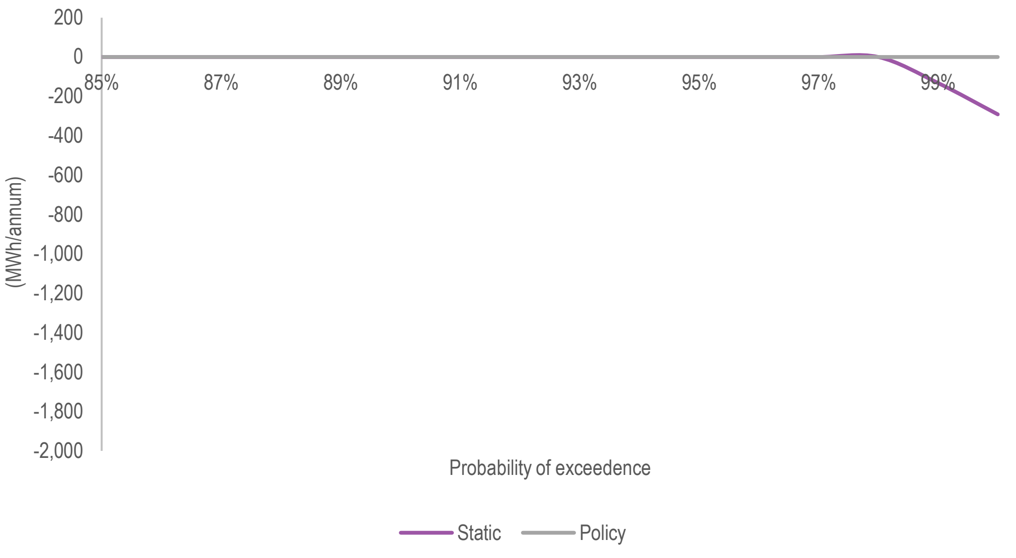
More specifically, in the static scenario, USE is projected to occur on approximately a one in twenty year (five per cent) basis in the absence of the emergency generator in 2017-18. The likelihood increases to a one in ten year basis in 2019-20 and then declines further when the solar thermal generator is available.

Even where USE does occur, there is typically not sufficient loss of load to 'trip' the reliability standard. In other words, the amount of energy that is not served is typically less than 0.002 per cent of the amount required in the year in question.

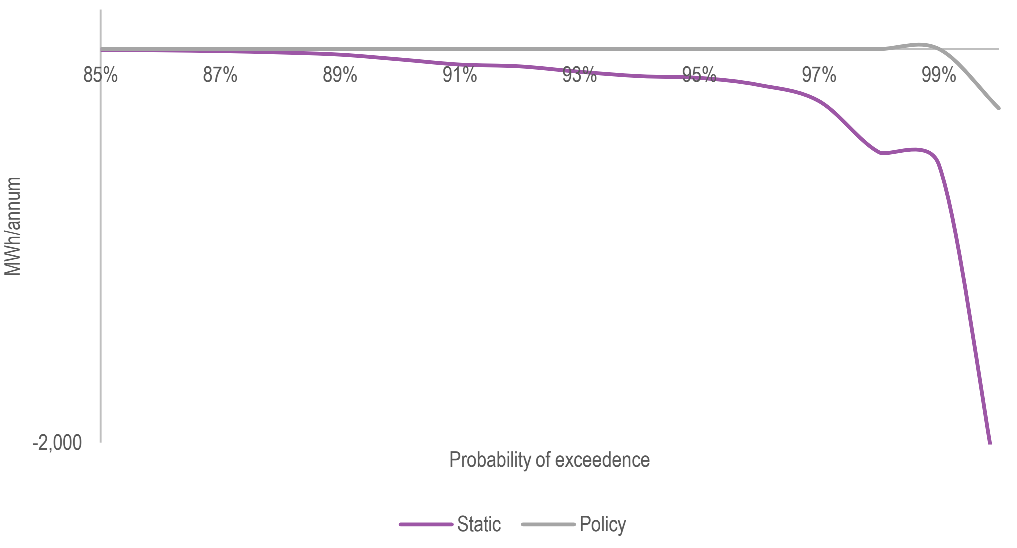
When the 276 MW generator is taken into account, the already very low level of USE discussed above is reduced substantially. With the emergency generator installed, USE only appears in the projections in on a one in one hundred year basis in 2021-22. In this circumstance, the reliability standard is not 'tripped'.

FIGURE 4.8 PROJECTED USE – STOCHASTIC SCENARIOS

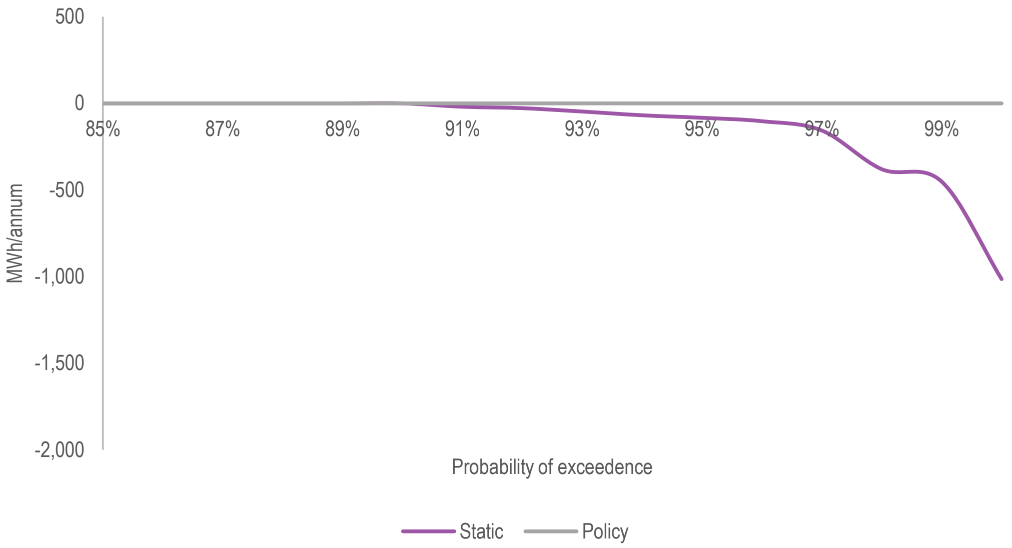
2017-18



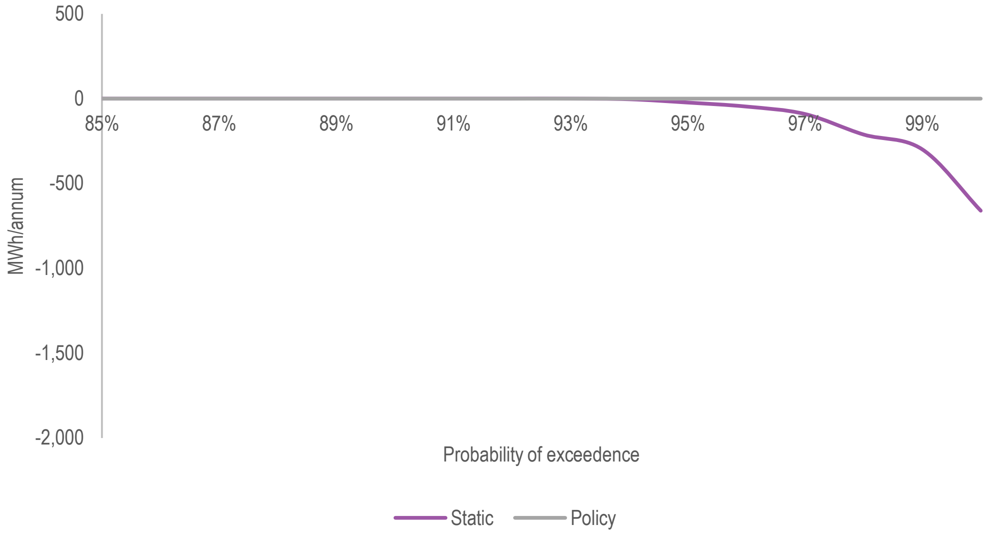
2019-20



2021-22



2023-24



SOURCE: ACIL ALLEN POWERMARK MODELLING

TABLE 4.5 PROJECTED USE IN MWH/ANNUM – STOCHASTIC SCENARIOS

	85%	90%	95%	99%	100%
		2017-8			
Static scenario	0	0	0	-132	-291
Policy scenario	0	0	0	0	0
		2019-20			
Static scenario	-4	-53	-147	-589	-2269
Policy scenario	0	0	0	0	-302
		2021-22			
Static scenario	0	0	-83	-452	-1015
Policy scenario	0	0	0	0	0
		2023-24			

	85%	90%	95%	99%	100%
Static scenario	0	0	-23	-299	-661
Policy scenario	0	0	0	0	0

SOURCE: ACIL ALLEN POWERMARK MODELLING

TABLE 4.6 PROJECTED USE AS PERCENTAGE – STOCHASTIC POLICY SCENARIOS

	85%	90%	95%	99%	100%
2017-18					
Static scenario	0.0000%	0.0000%	0.0000%	-0.0012%	**-0.0026%**
Policy scenario	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2019-20					
Static scenario	0.0000%	-0.0005%	-0.0013%	**-0.0051%**	**-0.0194%**
Policy scenario	0.0000%	0.0000%	0.0000%	0.0000%	**-0.0026%**
2021-22					
Static scenario	0.0000%	0.0000%	-0.0007%	**-0.0039%**	**-0.0087%**
Policy scenario	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2023-24					
Static scenario	0.0000%	0.0000%	-0.0002%	**-0.0026%**	**-0.0057%**
Policy scenario	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

SOURCE: ACIL ALLEN POWERMARK MODELLING

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