The Australia Institute
Research that matters.

Missing a Stitch in Time:
The Consequences of Underinvestment in Proper Upkeep of Australia's Electricity Transmission and Distribution System

Discussion paper

By Alia Armistead, David Richardson, and Jim Stanford

May 2021

ABOUT THE AUSTRALIA INSTITUTE

The Australia Institute is an independent public policy think tank based in Canberra. It is funded by donations from philanthropic trusts and individuals and commissioned research. We barrack for ideas, not political parties or candidates. Since its launch in 1994, the Institute has carried out highly influential research on a broad range of economic, social and environmental issues.

OUR PHILOSOPHY

As we begin the 21st century, new dilemmas confront our society and our planet. Unprecedented levels of consumption co-exist with extreme poverty. Through new technology we are more connected than we have ever been, yet civic engagement is declining. Environmental neglect continues despite heightened ecological awareness. A better balance is urgently needed.

The Australia Institute's directors, staff and supporters represent a broad range of views and priorities. What unites us is a belief that through a combination of research and creativity we can promote new solutions and ways of thinking.

OUR PURPOSE – 'RESEARCH THAT MATTERS'

The Institute publishes research that contributes to a more just, sustainable and peaceful society. Our goal is to gather, interpret and communicate evidence in order to both diagnose the problems we face and propose new solutions to tackle them. Donations to its Research Fund are tax deductible for the donor. Anyone wishing to donate can do so via the website at https://www.tai.org.au or by calling the Institute on 02 6130 0530. Our secure and user-friendly website allows donors to make either one-off or regular monthly donations and we encourage everyone who can to donate in this way as it assists our research in the most significant manner.

Level 1, Endeavour House, 1 Franklin St
Canberra, ACT 2601 Tel: (02) 61300530 Email: mail@tai.org.au
Website: www.tai.org.au ISSN: 1836-9014

ACKNOWLEDGMENT

The authors thank without implication the ETU, Trevor Gould, and the participants in our qualitative interviews for their support of this project.

Contents

Introduction

Australia's electricity industry constitutes a large and critical component of our national economic infrastructure. The industry produces $25 billion per year in value-added. It employs around 50,000 Australians, paying out $6 billion per year in wages and salaries. It makes $45 billion in annual purchases from a diverse and far-reaching supply chain, that provides the sector with inputs ranging from resources to equipment to construction to services.

Most important, of course, the industry literally keeps the lights on: it provides an essential input, electric energy, without which no other industry could function and the safety and comfort of Australians would be immediatel jeopardised. In this regard, electricity is clearly an essential service: a utility vital to virtually everything else that occurs in the economy and society.

Given that critical importance, we would assume that investing in the proper capitalisation, modernisation, upgrading and maintenance of this system would be a top priority of economic policy and corporate decision-making. Unfortunately, however, irrational and unintended consequences arising from the business-friendly, market-driven regulatory regime presently governing Australia's electricity sector have produced exactly the opposite result. A structural pattern of sustained underinvestment in the upkeep and quality of the transmission and distribution grid is jeopardising the safety and reliability of the network – and harming both the people who work in this industry and the customers they serve.

The present system was established on the assumption that profit-seeking behaviour of private businesses, with appropriate regulatory supervision, will best ensure an efficient allocation of resources, top quality service, and lowest possible prices for consumers. On every one of these grounds, however, the system has failed. Alongside chronic underinvestment in the system's equipment and reliability, there is abundant evidence of an enormous waste of resources by self-dealing, rent-seeking corporate entities – diverting billions of dollars of expenditure away from necessary upkeep, redirected to ultimately unproductive activities (including overlapping corporate bureaucracies, frenetic selling and re-selling within the industry, and intense financialisation) that have nothing to do with the production and delivery of reliable, affordable energy. The national grid is unable to meet several challenges to its safety and reliability: including its ability to safely withstand extreme heat and severe weather events, and its capacity to adjust to the accelerating roll-out of variable and distributed renewable generation investments. The workforce in the industry has lost

jobs and real incomes. And consumers (both residential and industrial) have faced an unprecedented and unjustified inflation of electricity prices.

To be sure, this privatised, fragmented, and badly regulated industry has been consistently and increasingly profitable for its owners. Given the monopoly power these energy businesses have been granted over a critical piece of public infrastructure, these profits are hardly a surprise. What is surprising (and disappointing), however, is how Australia's regulatory regime has failed to recognise and respond to these perverse outcomes. Despite growing evidence of deteriorating efficiency and reliability, and the inflation of both prices and profits, regulators continue with a business-as-usual approach to managing the industry. This approach routinely turns back legitimate requests for needed upgrades, modernisation, and maintenance on the system's real capital base – while turning a blind eye to the rampant waste of resources on unproductive and self-serving corporate functions. Given the increasing pressures associated with climate change, more severe and frequent bushfires, population growth, and the shift to renewable generation, this business-as-usual approach cannot continue.

A timeless adage reminds us that 'a stitch in time saves nine.' Prudent attention to maintaining productive assets in top quality condition, and upgrading capital in line with new technology and evolving best practices, is a hallmark of efficient and successful management. Australia's electricity industry is controlled by self-seeking private businesses, and a few state-owned corporations directed to act just like them. They are governed by a regulatory system which places far too much faith in the inherent efficiency of private sector actors. Hence the industry is failing to make that stitch in time. Australians will pay the price for the chronic neglect of proper maintenance and upkeep of our electricity system in many ways: through a system that is inefficient, unreliable, cannot meet the challenges of the coming energy revolution, is unduly expensive to consumers, and which in many cases is unsafe for both workers and the public at large.

This report provides evidence of a pattern of systematic underinvestment in the upkeep and capability of Australia's electricity grid, drawing on three major sources of data:

- A project to gather original qualitative data from dozens of power industry workers employed on the front lines of maintaining Australia's transmission and distribution network. Their personal and professional experience attests to a widespread and sustained pattern of underinvestment and neglect, and provides worrisome details regarding the consequences of that underinvestment for the well-being of workers, communities, and the environment.

- A review of other research and findings in the public doman (including several government commissions and inquries) regarding the importance of a top-quality, well-maintained electricity grid for our economy and society. These previous studies have also warned that the current system is falling behind in safe and efficient upkeep of its capital assets.
- A review of available quantitative data – from the Australian Energy Regulator, from the Australian Bureau of Statistics, and from individual companies. This review confirms the steady decline in allocations of real resources to the capitalisation and good operating condition of the transmission and distribution grid. And it documents the erosion of real maintenance and upkeep according to several indicators, alongside evidence of unprecedented inflation in both electricity prices and industry profits.

The main findings of this comprehensive qualitative and quantitative analysis include the following:

- First-hand accounts from dozens of electricity sector workers in various roles and all parts of the country confirm the ongoing failure of the current system to allocate adequate resources to pro-active maintenance, upgrades, and safety, with serious consequences for workers, community safety, and the environment.
- Real spending by the transmission and distribution sectors on operations and maintenance of the grid has been reduced by at least $1 billion per year since 2012.
- Adjusted for inflation and the expanded base of customers in the network, real operating expenditures per customer have declined by 28-33 per cent since 2006.
- Even within that contracting overall envelope of spending on maintenance and operations, several indicators confirm a reallocation of resources away from concrete system operation and maintenance, in favour of corporate overhead functions, re-selling, and financial activities.
- The transmission and distribution system now employs 40 per cent more managers and office-based professionals than electricians.
- Capital investment, spending on materials and equipment, capitalised own-use activity, and employment of electricians, linespersons, and related specialists have all declined markedly in the past several years.
- Fundamental measures of efficiency in the industry (including total factor and average labour productivity) have also deteriorated, dragged down by misallocation of resources to corporate and overhead functions.
- The squeeze on maintenance and upgrading expenses resulting from a combination of AER pressure and corporate profit-seeking has not produced

savings for consumers. To the contrary, prices for both residential and industrial users have soared dramatically (almost doubling in real terms) since 2000.

- High electricity prices have boosted revenues and profits in the industry – which have doubled in nominal terms since 2006, and grown substantially as a share of the industry's total value-added. The AER's superficial and ineffective oversight processes have not prevented private energy businesses from profiting through underinvestment in the industry's asset base, and exploitation of consumers and workers alike.

After reviewing this worrisome evidence of systematic underinvestment in the quality and capability of Australia's electricity grid, the report concludes with seven concrete recommendations to begin repairing and reversing these irrational and destructive outcomes. These include:

I. AER determinations of allowable capital, upgrading and maintenance investments by regulated businesses should be ascertained on the basis of concrete bottom-up auditing of system capability, reliability and performance, undertaken by independent arms-length technical experts. Regulation of capital and maintenance expenditures needs to be 'grounded' in analysis of real-world challenges and constraints facing the system – including assessments of additional requirements arising from climate change and severe weather, risk mitigation (including bushfire prevention and vegetation management), and challenges related to the growth of distributed renewable generation. A broader economic benefit test should be applied to ensure the interests of workers and the community are factored into decision-making around capital investments and upkeep.

II. Once appropriate levels of system capital and maintenance expenditures have been identified, explicit mechanisms must be established to reflect and recover those costs in regulated electricity prices.

III. When adverse events (such as severe weather, bushfires, or other occurrences) necessitate capital or repair expenditures above and beyond previously approved regulated levels, provisions for additional cost recovery must also be accessible.

IV. Costing of capital installation, upgrading, and maintenance expenditure must take explicit account of the need for high-quality skilled, certified labour to perform that work – including appropriate wages, entitlements and working conditions in line with industry best practices.

V. The accelerating transition to renewable energy sources, through both utility-scale projects and distributed sources, poses a unique and historic challenge to the capabilities of the national transmission and distribution grid. The AER, in conjunction with the AEMO and other industry bodies, should undertake a thorough assessment of the investments and system changes that will be

required to meet the new requirements of an increasingly renewables-focused power system. This assessment must incorporate a broader economic and social cost-benefit lens, rather than the current narrowly-defined conception of economic costs. The findings of this assessment must then inform the AER's subsequent determinations regarding allowable capital and maintenance expenditures by regulated businesses.

VI. Businesses which underspend allowed capital and maintenance budgets should be issued financial penalties which offset the impact of this underspending on their operating margins. This would eliminate the current perverse incentive for private transmitters and distributors to artificially suppress needed maintenance and upgrades in the interests of a short-term bonus over and above their already-substantial profit margins.

VII. The AER must undertake more detailed reviews of the submitted overhead, marketing, and financial activities of regulated energy businesses. Instead of providing blanket approval for whatever operating expenses companies deem to be in their interests, within an overall ceiling that is not differentiated with respect to specific cost activities, the regulator should focus on reducing the deadweight costs of duplicated, self-serving corporate bureaucracies.

It is past time for those in charge of Australia's electricity system – both private owners and government regulators – to acknowledge the widening tears in the fabric of this vital public service. And it is well past time for them to begin making the necessary repairs.

I. Reports from the Front Lines

This section of the report collates first-hand accounts of people working in the transmission and distribution networks, attesting to the chronic pattern of underinvestment in maintenance, upgrading, and system integrity that has emerged under the current competitive and regulatory structure of the industry. This evidence also recounts the respondents' experiences regarding the consequences of that underinvestment for asset quality, integrity, and safety.

The data is based on qualitative interviews with 25 power industry workers from a range of functions in the electricity transmission and distribution sectors: including lineworkers, vegetation officers, community stakeholders and network managers from across the National Electricity Market. Interviewees were associated with a wide range of companies: including Queensland's Ergon Energy, Energex, Energy Queensland and Powerlink; Victoria's Zinfra, Powercor, and AusNet Services; ACT's Evoenergy; NSW's Essential Energy, Endeavour Energy, and Ausgrid; Tasmania's TasNetworks; Northern Territory's Power and Water; and South Australia's SA Power Networks. We also interviewed several power industry officials of the ETU with responsibility for representing and advocating on behalf of power industry workers across these states and territories.

Interviewees were contacted by phone and briefed on interview topics. Semi-structured interviews ran for approximately 30-40 minutes and were conducted over Zoom. Transcriptions were generated from the interviews to allow subsequent analysis of key themes from each discussion.

The data collected through these interviews highlights widespread concerns among those working in Australia's electricity industry regarding the safety, security and reliability of our transmission and distribution networks. These concerns have been heightened by what workers perceive as insufficient investment in asset maintenance – the result of both poor management decisions at the company level, and flawed determinations from the Australian Energy Regulator (AER).

Interviewees raised significant concerns that insufficient maintenance has led to deterioration in the quality of infrastructure assets. This in turn leads to greater safety risks posed to workers and the community, and reduced power reliability for consumers. Interviewees also raised concerns that insufficient maintenance is undermining the potential for a successful transition to renewable energy sources, decreasing the resilience of the network to cope with extreme weather events, and

increasing the likelihood of asset failures directly causing harm to workers, communities and the environment (through disasters such as bushfires).

The case studies related by our respondents highlight a general awareness amongst those involved in the electricity system that profits are driving decisions (both by individual companies and by the AER), at the expense of worker and network safety and security.

Our description of the main themes arising from the qualitative interviews is organised into the following categories:

- Concerns about the deteriorating quality of system assets
- Lack of preventative maintenance, and a 'run to fail' approach to asset management
- Safety concerns for workers
- Safety concerns for the community
- Reliability of electricity service
- The flawed framework adopted by the AER
- The need to upgrade the grid to successfully integrate renewable energy
- Inadequate resilience in the overall network

Our discussion of the main findings of the qualitative research is illustrated with direct quotes from individual interviews. Respondents are not identified to preserve their confidentiality, but we do provide their state and position to indicate the geographical and occupational range of the interviews.

DECLINING ASSET QUALITY

Interviewees reported concern that maintenance budgets have been steadily declining over the past two decades, and reached all-time lows following the last rounds of AER determinations. As a result of reduced maintenance budgets, workers with technical training and understanding of transmission and distribution network assets believe that the maintenance necessary to ensure a safe and reliable network cannot be delivered with currently allocated funding.

All interviewees voiced concern that insufficient maintenance is leading to a significant deterioration of network infrastructure, and that ageing assets are being used far beyond their originally intended life cycle.

> "When you look at the age of the assets in Australia, there's a large percentage of assets that are reaching that end of life. So unless there's

> a realisation from the regulator, they have to look forward as well as looking backwards, inevitably you're going to continue to see the condition of the assets deteriorate". (Queensland power industry manager)

Maintenance investment tends to follow boom-and-bust cycles of neglect and asset deterioration, followed by a ramping up of investment in the wake of breakdowns to raise asset quality back to its previous state. One power worker from Victoria described this process:

> "They'll have a flavour of the month or flavour of the year where they'll concentrate on one area. It may only be power poles and the rest of the infrastructure will be left to decline until they then realise that they've got to play catchup." (Victoria power industry worker)

Inspection cycles have been extended from three years up to five years, which lineworkers highlight almost doubles the time between inspections. Interviewees were extremely concerned that extending the time between inspection cycles will lead to a greater risk of failure.

> "You start extending…the maintenance cycles of things like high voltage circuit breakers, you're getting closer and closer to a catastrophic failure." (Northern Territory power industry worker)

In areas prone to risk or where assets are exposed to harsh weather conditions, a significant amount of additional asset deterioration can occur in this extended timeframe.

> "Instead of opportunistic maintenance being done, instead of a best practise on asset inspection and condition of the network, the businesses are running a business model where they will let the asset go for as long as they possibly can. Almost a calculated risk. And the ones that achieve that calculated risk or achieve a good outcome on that calculated risk are often rewarded for it, which is an issue which encourages them to push that envelope as far as they possibly can. And effectively, it's almost like they're daring the infrastructure…to fail." (Victoria union official)

A Queensland power worker raised concerns that asset deterioration is often not visible to the naked eye, and so is often missed in routine inspections. In these situations there should be an improved understanding of the local environmental context that causes degradation to particular assets and better data modelling to

determine the age at which those assets will start to deteriorate. This interviewee was extremely concerned that this is not current practice; failures had been experienced that placed workers in life-threatening situations, and that were preventable if better practices were adopted.

> "The type of rot that occurs in that pole shows no warning signs, there's no testing regime that can pick up that type of rot. The only determining factor … is that it's in a floodplain area that commonly floods and it's over a certain age. There's no inspection regime that can pick up the type of degradation that occurred that caused catastrophic failure." (Queensland power industry worker)

This issue was also raised by interviewees from other states, who described concerning occasions when failure occurred because of a deteriorated asset that was not identified before a lineworker began completing a task.

> "We've had a pole fall over…a pole that had concrete around it so he couldn't do a digging inspection. That pole was rusted off just below the concrete and he was on a ladder… When they took the wires off the top of that pole, the pole fell to the ground… When you don't know if your poles are rusted off just below ground level, you don't know what you're dealing with… Five years ago or seven years ago, those twenty two poles got blown down: …they were all rusted off just below the ground level…this is the problem. When you wait for things to break, sometimes they really break… And that's when you have issues that really fall into the wheelhouse of public safety, worker safety and asset reliability." (South Australian union official)

Interviewees reported an increased frequency of asset failure in recent years, attributable to reduced maintenance, and were concerned that the rate and severity of network failure will continue to increase if asset management is not improved:

> "Assets fail every day of the week, every week of the year. Obviously the consequences are a lot greater in your warmer, hotter weather and a consequence doesn't have to be a bushfire – it might be not having power for two or three days because maintenance wasn't done and the system fails." (Victoria union official)

Interviewees varied in their estimation of how often insufficient maintenance leads to failure. Some were unsure about the frequency of failure, while others estimated that "preventable failures [are] happening probably on an hourly basis…It just depends of

the gravity of that failure." A Queensland power worker worker described their concern:

> "When the asset's in a lot poorer condition and nearing end of life, things like that will cause…greater impact and greater failure and…[a] longer period of time to to fix the asset". (Queensland power industry worker)

Even in cases where failures cannot be directly attributed to insufficient maintenance, there was consensus amongst interviewees that the risk of failure is higher now than in previous years, and insufficient maintenance can be considered a contributing factor. Resilience of the network is also reduced as a result of deteriorated assets: a better-maintained network could absorb impacts and still maintain function, yet assets in a deteriorated condition are more likely to fail.

> "It doesn't matter whether it's in distribution or transmission, you start extending maintenance cycles, you run the risk of failure of pieces of plant, which could lead to explosions in circuit breakers, poles falling down, wires hitting the deck". (Queensland union official)

The widespread practice of 'pole-nailing' or 'pole-staking' is done to extend the lifetime of power poles beyond their intended used-by date. Interviewees viewed this practice as a 'bandaid' solution that is typical of the management of the overall transmission and distribution network: trying to extend the life of assets beyond what they should ideally be for safety and reliability purposes, with the primary intention of saving money. Pole-staking was originally intended as a short-term solution, but some staked poles have been in place now for 20 years, which interviewees see as increasing the likelihood of preventable failure.

These 'bandaid' solutions are common practice. When restoring supply after an outage the same infrastructure is often repaired and put back in place, which concerned a Queensland worker because with each post-failure repair of an ageing asset, the quality of the infrastructure deteriorates further and is more likely to fail again in the future.

> "As the conductors age…the physical integrity of that conductor gets compromised. They are more prone to falling down… We're putting the same wire back up in the air and every time it falls down the physical qualities of that wire, the inherent strength of that conductor is compromised." (Queensland power industry worker)

Interviewees believed that some of the infrastructure in the network hasn't changed in 50-100 years, and that the new technologies being installed are not overly advanced in comparison with older assets. When replacements do occur, often after failure, old equipment is replaced with so-called 'maintenance free' equipment that is unlikely to have the same longevity that previous equipment had. Workers expect that they will have to replace this new equipment sooner. Additionally, replacement programs to upgrade old infrastructure have been sparse and insufficient to remove old, faulty infrastructure.

Advocates of the existing regulatory emphasis on reducing maintenance and upkeep epenses point to the so-called problem of 'gold plating': the alleged overinvestment in asset quantity and quality that preceded the downturn in overall electricity usage in recent years. This theory was viewed skeptically by interviewees, reflecting political rhetoric more than the on-the-ground reality which they work in. Investing in and maintaining high-quality assets, capable of delivering a safe and reliable service, is not 'gold-plating' – it is simply good management. After years of fiscal restraint limiting good maintenance practices, increased funding is now essential to raise the asset quality to acceptable levels. Moreover, interviewees noted that extra capacity and resilience is more necessary in the system today to cope with over-40 degree weather, severe storms, and other challenges – even if that extra capability is not often required. Making matters worse, if the assets in question had already been in use to their maximum capacity leading up to critical incidents, then it is all the more likely that the system will fail.

'RUN TO FAIL'

Maintenance practices have shifted from preventative, proactive maintenance to reactive maintenance, with power companies and the AER seemingly adopting a 'run to fail' management strategy for assets. This meaens infrastructure is not replaced at its pre-determined 'end of life', but instead managers wait for assets to fail before they are replaced.

> "We're seeing more and more investment by the businesses into technologies that allow them to leave these substandard structures in place and put a bandaid fix on them rather than actually replace that that substandard structure…They're left to fail before they are replaced often…They're still in the air, even though it's known that they fail." (Victoria power industry worker)

Some interviewees believed that the 'run to fail' strategy results from the desire to sidestep inefficient management processes and re-allocats funding, all in the contet of insufficient maintenance determinations from the AER.

> *"*If that piece of infrastructure breaks we're allowed to get in there and fix it straight away, rather than all that planning process and the money that planning process costs to fix something before it breaks. It's easier for them to fix it after it breaks. And that's where the risk management strategies come into place… It's not a good outcome for the electricity consumer. At the end of the day, if you incentivise a company to let things go until they break and it's easier for them to fix them, then that's what they're going to do. And I think that's what's happening in South Australia at the moment." (South Australian union official)

This belief that power companies are rewarded for utilising a 'run to fail' approach to asset management was common amongst lineworkers, who saw this management approach as providing a direct monetary benefit for power companies while simultaneously increasing the risk to infrastructure.

> "If a company chooses not to do maintenance and rolls the dice on that and it doesn't break, then the money they haven't spent, they get to keep. Plus they get a bonus from the AER. So they're rewarding and incentivising poor behaviour. When large parts of the network fail because of that underinvestment and the increasing weather events from climate change, then the companies are gaining access to the work that they should have been planning for and doing via an AER mechanism called a cost pass through application. And when those events occur, the companies know that they're likely to meet the cost passthrough threshold. And when that happens, no expense is spared. So it's really just deferring risk and then finding a loophole at a later date and time that they can recover not only the amount, but probably more than what they would have got if they had been proactive." (ETU national union official)

Workers identify this as dangerous because "when they fail, they don't fail safe*".* Risk assessment is performed on infrastructure assets to determine when and what type of maintenance needs to done, and these assessments are more 'risk tolerant' now than ever before. Risk assessment for asset maintenance purposes is done with an underlying profit motive in mind, to determine whether maintenance can be delayed to a later date. When asked whether the risk analysis on assets is sufficient, an

interviewee replied, “No, I don't think it's sufficient because it's primarily based on dollars, not reliability or safety.”

Many interviewees believed that the current trend of reduced maintenance, risk tolerance and ‘run to fail’ management is primarily a result of profit-motivated cost cutting in the power companies and driven by the AER:

> “The regulatory environment is an economic regulatory environment and they tend to push you to do economic analysis to justify the expenditure... You’ve got this over-reliance on economics…and under-reliance on on proper engineering assessment in making these conditions.”

> “AER issued a guideline that says I should do economic analysis of every investment case. And to do that, I have to put a dollar value on a fatality… it's almost impossible to put together a business case that the AER accepts as reasonable for some of this safety-driven investment.” (Queensland power industry manager)

This manager also highlighted that ‘run to fail’ is:

> “…a legitimate asset management strategy for some asset classes…[but] where you’ve got potential significant consequences associated with failure, run to fail’s not acceptable.” (Queensland power industry manager)

Interviewees described incidents of repeated failure on sections of line and lineworkers repeatedly reporting those infrastructure risks – which were met with approval to replace only a small section of the infrastructure. Lineworkers view this approach as insufficient to deliver an optimally safe and reliable service.

Underground assets are often neglected in maintenance planning because they are more difficult to access. Maintenance requirements for underground assets are less than overhead lines, but the same ‘run to fail’ mentality is used in waiting for the infrastructure to fail before it is dug up for repairs.

Issues raised by lineworkers were not limited to rural and regional areas, though many did highlight that in rural and regional areas of low population density there isn’t considered to be a sufficient customer base to warrant upgrades or maintenance that may be deemed more economically justifiable for metropolitan regions.

There was variation in workers opinions as to whether infrastructure assets meet regulatory standards. Some interviewees believed that asset condition would often not

meet the regulatory standards set by the AER, whilst others believed that assets would mostly comply with regulations. However, even these interviewees were concerned that the regulatory standards were insufficient to provide optimal safety and reliability. And while assets might comply with the standards, the poor conditions of assets nevertheless negatively impacts workers' ability to perform necessary tasks effectively and efficiently.

SAFETY FOR WORKERS

All interviewees were extremely concerned about the safety risks that are placed upon them by working on deteriorating network infrastructure. Working on poor quality infrastructure is riskier and more difficult. Interviewees described situations of working on assets that they perceive as at risk of failing while working on them.

> "Sometimes the conductors are that small and that rotten, we can't touch them, they'll fall apart." (Victoria power industry worker)

Some replacement programs for old, faulty infrastructure have commenced in the past, but were either insufficient to mitigate risks or were not completed.

Lineworkers believe that current asset management strategies place them in the difficult position of having to reconcile their own safety with pressure to maintain assets to as good a standard as they are permitted to do within allocated time and funding.

> "They're being sent out to work on an asset that isn't just ageing. It's deteriorated to the point where it is a hazard to work…and it puts them in a position to that someone's going to get that work done. But if you're being sent out to an unsafe work environment, it's sort of they need to think of their own safety. But then by thinking of their own safety, sometimes that can impact on whether a job can get done or not" (Victoria union official)

Lineworkers are more overtly responsible for their own safety by having to choose whether to complete a required job or not. This could also raise questions around the safety and risk assessment training that workers receive, concerns about human error, and worker concerns about job security influencing risk assessment decision making.

> "They put the onus on on an individual risk assessment. So it's basically the people who are working out on site, they're put under pressure to to do a risk assessment and deem whether the conductor or the polls or whatever we're working on are of serviceable condition. But the

> problem is, is like any linesman, you get put under pressures to get the job done. And it's also a pressure of you want to do a good job, you know, you want to do the best you can. And sometimes I think the company should actually get experts in, like an engineer … to do the risk assessments, not leave it up to the individuals on the day which have pressure to get the job done" (South Australian power industry worker)

Safety for workers is also traded off against efficiency and pressure from power companies to keep electricity supply on. Some interviewees raised concerns that they are increasingly expected to conduct works without turning power supply off where they previously would have shut down power. Other interviewees said they had to more frequently cut power supply for safety reasons before works could be conducted.

> "The job's made more difficult if the assets [they] are going out to work on are not safe…. It's so old and brittle that you can't work on it. So you have to make it dead, so it makes them less efficient because of the poor condition of the assets. If you've got poles that are unsafe to climb or unsafe to work on because they might fall over, that can create some hazards for the workers. So so if you've got assets that are past the point where they should have been replaced, and that does create extra hazards, and in some places we put access restrictions on things to keep workers safe." (Queensland power industry manager)

Skilled workers and worker awareness of increased safety risk because of declining asset quality were regularly raised by interviewees as crucial to network integrity. If workers were less skilled and had less understanding of the low infrastructure quality, failure rates would likely be even higher and directly attributable to insufficient asset maintenance.

> "I suppose the only reason we don't have more incidents is our tradespersons are that good." (Victoria union official)

A Queensland ETU delegate said that there were many instances in which safety regulations did not protect workers or prevent them from potentially harmful situations. The delegate described a number of instances of conductor failure that had not been reported and repaired, in which it was 'good luck' and workers' instincts that prevented them from being seriously or fatally harmed by taking extra precautionary safety measures beyond what regulation and training dictated they should do:

> "I can think of six people, including myself, who are alive today because of good luck, nothing else, absolutely nothing else." (Queensland power industry worker)

Cuts to staff numbers mean that there is reduced capacity to complete the maintenance that has been allocated and funded, increasing the pressure on lineworkers to complete tasks quickly, potentially with the risk of incentivising workers to cut corners.

> "We lost 100 fieldworkers, 100 powerline workers in one hit pretty much last year. And we're still doing the same amount of work that we were with those people. So the maintenance has gone well down because we've got lack of numbers." (South Australian power industry worker)

Despite the limitations that are placed upon workers,

> "…the workers in this industry are highly skilled. They're well trained. And that's a credit to those organisations. They do try and adhere to an extremely high level of safe work standards." (ACT union official)

Workers reported that they regularly raise safety concerns associated with insufficient maintenance to upper management, yet these concerns seem to regularly 'fall on deaf ears'. There is also genuine fear amongst workers about regularly raising issues that they believe will not be listened to due to job security concerns.

Additionally, some interviewees raised concerns over safety operating rules. One interviewee believed that local knowledge is the driving factor in ensuring worker safety because there are often grey areas and a lack of safety rules about the criteria for safe and unsafe operating. In this situation, local knowledge is necessary for workers knowing which sections of the network are deteriorated or high risk. However, new or external crews who might be bought in to operate on the network will not have that understanding and so be exposed to greater safety risks. "I think local knowledge plays a lot more into our safety and the general outcome to everyone than they value," said a South Australian power industry worker.

Interviewees felt frustrated that they are being stopped from conducting the maintenance that they believe is necessary. "I think the frustrating thing for the fieldworker is to go to a pole with three or four obvious faults or maintenance issues on it, but only…being able to do one…and being told the rest of them aren't in the budget," said a South Australian power industry worker.

Many interviewees expressed concern that their capacity to work safely and efficiently is hindered by management processes.

> "You operate with with a blinkered approach…It doesn't matter what else you see out there, unless it's extremely bad and you think it's going

> to fail there and then. And even then there's a heap of checks and balances. It's not just 'hey we think this needs replacing, we're going to go fix it'. It has to be signed off, ticked off, so on and so forth. But it's now a discouraged practice. So our tradespersons on the ground, although they care about the network and they take their job very seriously, they're now exhausted with highlighting problems with the network and not being given the authority to go and fix those issues." (Victoria union official)

Interviewees expressed genuine concern over their ability to maintain a safe and secure network. Interviewees highlighted that they want the grid to be as safe and secure as possible, both for workers and customers, and they take pride that it is their job to ensure quality power supply to electricity consumers.

> "Nobody wants to leave an unsafe network." (NSW union official)

COMMUNITY SAFETY

Risks to workers flow into the community, and many interviewees believed that insufficient maintenance directly impacts on public safety:

> "At the end of the day, the lack of maintenance is is delivering an unsafe product to the consumer, to the communities" (Victoria union official)

Many interviewees gave examples of network infrastructure failure that could have directly harmed members of the public and considered it 'good luck' that risks to the public do not lead to injury and fatality more frequently.

> **"**I had a pole fall one night in …a very busy street in a very busy suburb … and it just was just fortunate it happened at 4 o'clock in the morning and it was just fortunate that we could get out there and get the crane and get it off the road before peak hour in the morning. But if it had happened in peak hour, that would have killed someone, kid going to school, person sitting in a car at the lights, peak hour traffic. It fell straight across the road and it would have just been cars there if it happened at eight o'clock in the morning. So it's life threatening both for workers and for the general public and consumers." (Victoria power industry worker)

There is belief that the public are generally unaware of risks posed to them by electricity infrastructure, are reasonably happy with reliability and concerned foremost with the cost of electricity. Interviewees believe that public concern about electricity

prices is a critical driver of funding cuts for maintenance, yet maintain that if customers were aware of the extent of safety risks both to workers and electricity consumers, most would be happy to pay marginally more for their electricity.

> "They'd have a different opinion if they were aware of the risk of safety, if they were aware that the corporations continually cut vegetation budgets…If the average punter was aware of those risks, particularly in relation to potential bushfires, I'm sure they would have a different attitude". (Queensland and Northern Territory union official)

Other interviewees echoed this sentiment that customers want and expect safe transmission and distribution networks, but are generally unaware of the maintenance required to deliver such a service. Customers also expect maintenance, upgrades and energy transitions to occur with orderly time and process without sacrificing safety and security.

> "I think that there's been a lot of public rhetoric about electricity pricing, and I think that's getting in the way of better collaboration to get good outcome[s] for customers…They want safety. They want reliability. They want us to make green our network that enables green technology. They want affordability, but they don't want it at the expense of the network falling down." (Queensland power industry manager)

Interviewees working in rural and regional areas view cuts to resources and the removal of local knowledge through redundancies and the closure of depots as exacerbating risks caused by poor quality infrastructure:

> "They're taking away a lot of local knowledge that know this area, that has experienced some pretty horrific bushfires. And so they are moving resources away from the area that has been exposed to a very high risk in the last five years. And I see that as a huge, huge risk to the community." (South Australian power industry worker)

SERVICE RELIABILITY

Interviewees highlighted that if regular proactive maintenance was funded, there would be greater capacity to keep the power on while future maintenance works are conducted. Instead, there is an increased need to turn power off for worker safety reasons, which increases expenditure and decreases efficiency for workers completing tasks and reduces the reliability of power supply to consumers.

Some interviewees experience increased pressure from power companies to keep the power on while conducting works, increasing safety risks to workers in situations where power would ideally be turned off before working on the power lines. In this way, an increased risk and safety burden is placed on workers. Others described being forced to cut power supply to conduct works solely because of the deteriorated state of the assets, whereas if maintenance had been consistent then some of that work could have taken place with supply on. This reduces efficiencies for workers and also decreases reliability of supply for customers.

> "The things we used to tie away live we now have to dead tie. People are losing power a lot more…because we're so under resourced as well that we ended up having to just take everyone off instead of dead tying and keeping the community on. So instead of 30 customers it ended up being nine hundred and thirty customers off for the day. And I mean, that's you taking businesses, vineyards, all sorts of people off - life support customers. But it's also the extra time notifying all of those as well and complying with all the notification requirement. So, yeah, the network is definitely limiting our ability to give a good service to the community." (South Australian power industry worker)

Other interviewees suggested that power companies are less willing to guarantee supply if it is cheaper to keep supply off.

> "Generally in the past, they do pretty much what they could to get the customers back on line as quick as possible… they are more willing to leave customers off for a period of time, so they can be just dealt with on the next ordinary shift, thus saving the company money on paying employees overtime." (NSW union official)

Concerns were also raised that reliability is reduced as a result of letting infrastructure fail because if failure occurs it can be classified as an emergency, with emergency crews and processes used to fix the issue. This sidesteps standard processes of notifying electricity consumers in advance of power outages.

> "When something breaks, it's an emergency. And that means all the rules go out the window and you can do whatever you need to do to fix it… [If] there's a wooden crossarm that's about to break somewhere and you need to plan that job then you've got to notify everyone five days out, you've got to make sure the crews are available… There's a lot of ancillary work that goes into to making that happen. And all of that has costs attached to it. Whereas if that wooden arm breaks all of a sudden, you've already got a standby crew on call and you don't have to notify

> anyone whatsoever. So it's simply one phone call to the company to say, I've got no power from a customer. And then the company calls the truck and the truck goes and fixes it in… So on one side, you've got all this ancillary work that's required to do preventative maintenance. On the other side, you've got a three step process." (South Australian union official)

One interviewee connected outage frequency predominantly with weather events, fluctuating seasonally with weather changes:

> **"**We used to have a much more frequent maintenance schedule with our equipment and it changed just prior to privatisation…outages are totally connected more than anything with the weather, so bad weather just causes a massive amount of outages." (NSW power industry worker)

Additionally, asset quality used to be higher before privatisation when there was more investment in preparation for increased demand on assets:

> **"**Prior to privatisation the government knew that we needed to sell a very good product and so they spent a lot of money on it. The term they used was gold plating… which was, in my opinion, exactly what it needed to get to be ready for any future development. Extra load, more population in the country, and the capacity then was the best I've ever seen it just prior to privatisation… After that I've seen a steady decline in the maintenance in the network. There's more focus on capital works and there's more money in it for the companies with the capital works than what there is in maintenance." (NSW power industry worker)

Seasonal weather impacts were also viewed as hard to plan for, with the severity and timing of impacts being unpredictable. This interviewee suggested increased staffing levels to manage weather-related impacts on the network. Inadequate staffing levels were also thought to contribute to the difficulty of managing outage frequencies.

Another interviewee believes there is a significant over-reliance on contractors, who do not have the necessary skills to adequately manage issues on the network. Staffing shortages and the prevalence of contractor usage was partly attributed to decision-making and funding from the AER.

THE AER'S FLAWED FRAMEWORK

Interviewees consistently did not believe that upper management within the power companies and in the AER had a good technical understanding of the operational requirements of the network and the level of maintenance that should be funded to ensure safety and reliability: "The most recent determination demonstrated the complete lack of understanding by the regulator that the asset is in that condition and that we need to do something about it," said a Queensland power industry manager.

A South Australian union official was similarly concerned that the AER had no understanding of the deteriorated state of infrastructure assets:

> "I've seen maps of the amount of defects that are on the network currently, and that is a scary thing… [It] would be a very good tool for the regulator to actually better understand…the state of decay of the system… These regulators need to understand the state of decay of our assets… so that they can actually assess that against their financial plans for the next five years." (South Australian union official)

Some power workers believed that technical understanding exists up to a certain level of management within the AER, because some of them have transitioned from working within the industry itself. However, even those officials have "just resigned to working within a system that isn't conducive to efficiently replacing and upgrading the network where required," according to a Victoria union official.

This contributes to ineffective regulation of power companies and assets by the AER:

> "If the regulator doesn't have the capacity to regulate as per the condition of the asset, then we need a new regulator… Financial regulation is one thing, but…an electrical fault can kill residents and it's not something that should be monetised… You can't blame the distribution business or the transmission business for [using] something cheap if they're allowed to do it."(South Australian union official)

Interviewees were critically aware of the growing portion of employees within power companies in roles such as accounting, sales, marketing and IT, and identified that these people do not actually get electricity to the consumers. In contrast, workers whose responsibility it is to ensure a safe, quality service are being increasingly neglected.

> "None of the key people…in those senior roles nationally have got any understanding of distribution networks…We need to have a more end

to end perspective if we're going to get this right." (Queensland power industry manager)

Interviewees viewed the increasing number of non-technical employees as symptomatic of the AER's shift towards economic management and away from technical and safety regulation.

> "it's an economic regulator sitting under the ACCC…instead of being a technical regulator. And what we've seen through that process is that it also drives the behaviour of the network companies: from being technical entities that deliver an essential service to being economic entities that are really focussed on numbers… That drives a very different behaviour in the organisations. And we think that's being driven by the economic regulatory environment, meaning that they need increasing numbers of managers with … financial and accounting backgrounds." (ETU national union official)

Interviewees were concerned that the AER considers only financial implications in making determinations, and that the lack of understanding of the needs of the network currently and in the future is a problematic network management strategy.

> "The AER covers financial only. They don't know what the system's like, they don't understand what it's like…I think a regulator just to simply financially regulate an essential services system is almost negligent in itself." (South Australia union official)

Interviewees expressed frustration regarding the AER's framework for making determinations and implementing regulations. The AER's framework forces power companies to expend significant resources in the effort to receive their desired determination, but does not audit or require companies' spending budgets to be consistent with their intended spending.

> "The power companies, particularly the larger ones, literally spend millions of dollars and years developing their determination proposals and doing the consultation with the regulator and the community, all these kinds of steps that they're required to take - millions of dollars. At the end, once the determination is issued and they've got their budget for five years, the AER never checks once to see if the company actually spends any of the money that it said it would spend on the things that said it would spend it on. And in fact, when we asked the AER about it, they say that that's not their job. … The network company itself is not required to spend a single dollar of its five year budget in the way that it

said it would. So what's the point of this entire process other than to create a whole bunch of non-productive work for no real outcome for consumers and we're seeing detrimental outcomes for workers through depot closures and decreased safety?" (ETU national union official)

Many interviewees also raised concerns that the specific contexts of a network section are not factored into decision making, with network requirements, capacity and efficiencies benchmarked against networks in different states that are not comparable:

> "They don't look at the geographics. They don't look at the…climactic conditions. They don't look at the distance of line per customer." (Queensland and Northern Territory union official)

> "The AER looks at all the network companies in the national electricity market and they decide who's cheapest for a particular activity. And then they tell all the other network companies, regardless of the geographical location they work in, regardless of the voltage, you know, the construction methodology, the climatic conditions, they say to every other participant, you have to do what the cheapest one did. And often what we're seeing, the cheapest ones are the privatised entities who aren't doing the maintenance, who are cutting the corners, who was … 'sweating' the assets. And they're being benchmarked as the frontier that every other network company is supposed to perform to that standard, by the AER. That standard is inefficient and dangerous to the public and unsafe for workers." (ETU national union official)

Interviewees believe that there should be a review or accountability mechanism of the AER's determinations and the impacts and effectiveness of AER management and regulatory changes, raising concerns that currently there is no regulatory impact assessment done to determine how rule changes influence safety, efficiency and reliability. One interviewee raised the possibility that this issue could be addressed by having power company employee representation in the AER at a board level.

> "There's no review at the policy level by government of the effectiveness of the AER… The corporate administration of the AER needs to have worker representation on it: …something to force the AER to be accountable for its decisions and to measure the success of its policy implementation." (ETU national union official)

RENEWABLES

Several respondents raised concerns that customers with rooftop solar were not receiving the full benefit from their investments through feed-in tariffs because the quality of the infrastructure connecting them to the grid is insufficient:

> Workers "get a lot of quality supply jobs for solar that keeps tripping off on high volts because the conductor is just too small for the solar… A lot of people's solar isn't working because of this. The conductor is just far too small or they're too far too rural… The consumer is missing out on getting that in feed tariff. But also the community is missing out on having that renewable available." (Victoria power industry worker)

Most interviewees believed that upgrading the size of transformers and conductors is a necessary but not technically difficult solution to optimise renewable energy in the network.

While positive about increasing the share of renewable energy in the grid, many interviewees were concerned with connecting new renewable assets to dysfunctional, ageing infrastructure:

> "There was a lot of push back at the start of that power quality and how it matches with coal fired generators…But we're not seeing as much negativity around that at the moment. We've now resigned ourselves to the fact that change has happened and it hasn't ended the world. So it's a matter of modifying our current networks, which need to be modified anyway, to accept more and more renewable input." (Victoria union official)

Many interviewees said their concerns about the lack of maintenance and deteriorating infrastructure quality would stay the same regardless of the source of energy supply.

> "With renewable energy, you still need assets to get the power to people's houses… You need to have a safe network or safe assets to be able to deliver that renewable energy to the consumer… They build new lines to get it to a point. But… at some point, it will then connect back up to an ageing asset that's going to have increased demand on it, which increases the risk of it failing."(Victoria union official)

With increasing investment in transitioning energy supply to renewable sources, now is the time to also invest in quality infrastructure to deliver that power to customers.

Some interviewees were concerned about renewable energy being blamed for reduced reliability of the grid, because "solar is is showing the grid's weaker points… What they're doing is is offering bandaid solutions to cover up the weaknesses instead of actually upgrading the asset," said a South Australian power industry worker.

A number of interviewees highlighted the need for a coherent strategy to plan investment for an orderly transition to a larger share of renewable energy:

> "I think the biggest problem at the moment is the lack of a coherent policy, a federal policy on what it looks like." (Queensland power industry manager)

This sentiment was echoed by a number of other interviewees:

> "If we keep going in Australia without a national framework, a national policy direction, investment simply won't come here." (Victoria power industry worker)
>
> "I think if we had the correct leadership, I think it would get done…pretty quickly and pretty smoothly." (NSW union official)
>
> "I suppose the big issue here is that we have a federal government that has no energy plan or strategy." (Victoria power industry worker)

NETWORK RESILIENCE

Most respondents were extremely concerned about the resilience of the network and its capacity to cope with extreme weather events. Interviewees were generally aware that the severity and frequency of weather events pose a risk to transmission and distribution infrastructure, and many attributed future challenges to climate change.

> "I suppose if you invest in renewables and do something about climate change…these weather events would become less normal… That would be a good start." (NSW union official)

Interviewees believed that insufficient maintenance to date has made the network more vulnerable than it needs to be. A network that is safe, secure and appropriately maintained will have high reliability even in the face of challenging conditions and transitions. Additionally, increased maintenance investment is needed to return network resilience to a historical baseline, and then raise it further.

> There has always been "a big risk and [the] network is not set up to deal with the 20 percent, the top 20 percent of storm events and things like

> that…We know what to expect, but the infrastructure is not there. It's not at a level where it can deal with it…The infrastructure is deteriorating while weather patterns and climate change are becoming more of a factor." (Victoria power industry worker)

Interviewees identified two roles for maintenance regarding resilience to extreme weather events: the network's capacity to maintain power supply during extreme weather events, and a safe and reliable network that does not directly cause disasters. Vegetation management was often raised as the main issue driving the network's contribution to disaster events, mainly bushfires.

A lineworker raised an example when vegetation near the powerlines started a bushfire, but in this instance the power network was found not to have breached their obligation for vegetation management. This highlights the potential for regulatory requirements to be nominally met by power companies, who are therefore not deemed to be at fault, but the network nevertheless can still cause significant failure and damage. It would therefore be beneficial for regulatory standards, in this case regarding vegetation management, to be reassessed to determine whether current standards are sufficient to prevent things like bushfires.

> "They limit their legal obligations. But I think sometimes we need to step outside those and think what's best." (South Australia power industry worker)

Vegetation management was raised by a number of interviewees as a maintenance area that is regularly underfunded by power companies, or one of the first to be sacrificed when budgets are cut. This is compounded by the AER benchmarking power companies against others.

> "Different network companies are prepared to risk the vegetation budgets. And once one does that, through that issue of frontier networks and benchmarking against the cheapest and nastiest, it pressures the others. So we regularly see the vegetation component of regulatory determinations decided by the AER slashing vegetation requirements, putting pressure on the company to reduce the area around the powerline that's going to be cleared. So rather than clearing all vegetation at least three metres away from the wires, that becomes two and then one point five and then one. And then of course in severe weather events... you end up with branches on the wires much more frequently, you end up with longer outages." (ETU national union official)

Many interviewees raised concerns about infrastructure being replaced on a like-for-like basis, including cutting costs by putting in infrastructure that workers believe will fail and have to be replaced sooner instead of high-quality, more resilient infrastructure. Timber assets such as wooden poles and crossarms are particularly vulnerable to deterioration. Aged timber assets that are replaced are often still replaced with timber instead of concrete or composite material poles, despite issues such as rot and burning in bushfires. One interviewee also expressed concern that funding for rebuilding after disaster damage to infrastructure was still insufficient:

> "We just went through one of the worst bushfire seasons ever in Australia… I'm pretty sure the maintenance levels haven't picked up as much as they should have to negate what happened last year." (South Australia power industry worker)

Upfront costs are necessary to raise the quality of asset infrastructure and build resilience in the network, with savings and efficiencies possible if this is done in advance:

> "So you build resilience by the design of your new assets. And the marginal cost of that resilience is relatively low if you do it up front." (Queensland power industry manager)

CONCLUSION AND SUMMARY

This section detailed the first-hand experiences of 25 power industry workers from the transmission and distribution sectors across Australia. Interviewees identified that delivering electricity securely and safely to customers is an essential service. Disruptions to electricity supply, particularly for long periods of time, can have significant negative impacts on people's lives. One interviewee was nostalgic for a previous time when the industry was focused on a mandate of public service:

> "Electricity used to be deemed to be a service to consumers instead of just a tradable commodity, particularly in Victoria. That would help change the whole principle of energy, that domestic supply has got to be reconsidered as a social justice matter." (Victoria power industry worker)

This sentiment was echoed by many other power industry workers who lament the impact of privatisation, fragmentation, and perverse regulatory actions on their ability to provide the highest quality service.

Interviewees consistently drew links between the insufficient maintenance activities of individual power companies, and the overall regulatory context for those actions, shaped by the pattern of AER determinations (which have put sustained downward pressure on maintenance and upgrading activity).

Moreover, our respondents have direct experience with the negative impact of underinvestment in maintenance on the safety of workers in transmission and distribution. And those safety concerns are not limited to workers: interviewees also identified that safety risks are also experienced within the broader community, and in some cases pose direct threats to the safety of communities and electricity consumers.

Insufficient maintenance has contributed to the deterioration of infrastructure asset quality. A rapidly-ageing network is then leading to more frequent occurrence of failure, ranging in impacts from short power outages to 'catastrophic' multi-day blackout events, injury and fatalities.

Our interviewees also observed that the long-term reduction in maintenance funding has reduced the reliability of electricity supply to consumers. Reliability is expected to further decline as reduced asset quality contributes to the risk of failure, and as extreme weather events and natural disasters become more frequent and severe. Increased investment in network security is needed to ensure the resilience of the network. Additionally, the transition to a larger role for renewable energy in the network must be supported with investments in quality, reliable infrastructure to optimise energy transitions, respond to the shifting geography of generation (as more widely distributed renewable assets are rolled out), and enhance service delivery.

II. Other Studies of the Consequences of Inadequate Maintenance

The preceding section provided a rich set of original qualitative data regarding the chronic pattern of underinvestment in transmission and distribution maintenance under Australia's current regulatory and competition regime. It confirmed a widespread and systematic inadequacy in preventative maintenance, upgrading, and integrity assurance across the national grid, with direct and real consequences for safety, reliability, and performance. If anything, this problem is getting worse over time: with an ageing and inadequately-maintained capital stock increasingly unable to deal with the pressures of a growing population, shifting composition and location of generation assets, and climate change.

Our findings of systematic underinvestment in maintenance and its many consequences are consistent with a broad body of previous research and investigation regarding the state of Australia's transmission and distribution assets, and the risks posed by inadequate infrastructure to safety, reliability, and the environment. Other studies and reports also document the growing risk that ageing and/or deteriorated electricity network assets will fail, contributing to a range of negative outcomes including blackouts, accidents, and bushfires. For example, across Australia electric faults cause approximately 2.2% of vegetation fires.[1] While that is less common than some other sources, fires caused by electrical faults become more prevalent during elevated bushfire risk periods, and tend to be worse and harder to control than fires from other causes.

Previous public inquiries have documented the consequences of electricity grid failures for bushfire events and other risks. There is also a strong body of evidence that the electricity network is vulnerable to failure during natural disasters of many kinds, with negative implications for other interdependent infrastructure (such as telecommunications). This section of the report will survey and summarise the relevant findings of other research in the public domain regarding the consequences of underinvestment in system maintenance, safety and integrity.

[1] Miller *et al.* (2017).

ROYAL COMMISSION INTO NATIONAL NATURAL DISASTER ARRANGEMENTS

The 2020 Royal Commission into National Natural Disaster Arrangements identified that damage to electricity transmission networks from the unprecedented 'Black Summer' bushfires (2019-20) in turn caused widespread failures in essential services and critical infrastructure operations.[2] Network failures were largely attributed to fire damage to more than 10,000 power poles, and thousands of kilometres of above-ground and underground powerlines.

The report highlighted the 'essential service' nature of electricity supply. Power supply outages negatively impact on interdependent critical infrastructure for communities and other services – including telecommunications, access to water, phone coverage and credit card payments. Impacts are distributed unevenly throughout communities, and disproportionately affect vulnerable communities and individuals. For example, people on life support and those living in isolated areas are especially vulnerable to outages. The report recommends that a holistic understanding of electricity and telecommunications infrastructure interdependencies be fostered, including integrating risk management and risk mitigation across responsible agencies.

Strategies that could be employed toward this end, according to the report, include:

- replacing timber power poles with concrete poles
- increasing vegetation risk assessment and management efforts around infrastructure assets
- strategic modelling to identify infrastructure exposure to hazards
- strategic modelling to identify optimal replacement or relocation of infrastructure
- moving powerlines underground to reduce hazard exposure (recognising that this does not completely negate exposure to disaster risks)
- consider establishing stand-alone power systems

The report identified that federal, state and territory governments share responsibility to ensure critical infrastructure capacity, resilience and risk management, and that

[2] Commonwealth of Australia (2020).

AEMO should play a national coordinating role to engage in contingency planning with Transmission Network Service providers.

Ther report's Recommendation 9.4 for 'Collective awareness and mitigation of risks to critical infrastructure' outlines that the Australian Government, with state and territory governments and critical infrastructure operators, should identify and assess risks to critical infrastructure from natural disasters, implement measures to mitigate these risks, increase resilience and track measures against an agreed plan. Achieving this recommendation will obviously require attention and resources within the national transmission and distribution system – and that, in turn, clearly requires a shift in the current regulatory and competitive practices which have constrained and discouraged these needed investments.

VICTORIAN BUSHFIRES ROYAL COMMISSION

The 2009 Victorian Bushfires Royal Commission identified that although the overall percentage of fires caused by failures in the electricity infrastructure is low, the percentage of fires linked to electrical assets during extreme fire danger days rises dramatically.[3] Five of the 15 fires examined by the Commission were associated with electricity asset failure. Victoria's ageing electricity infrastructure contributed to three of the devastating electricity-caused fires on 'Black Saturday' (7 February 2009) in Kilmore East, Coleraine and Horsham. More broadly, electricity assets are the cause of more than 200 fires in Victoria per year.

As Victoria's electricity assets continue to age (as a result of underinvestment in capital replacement and maintenance), and the distribution network approaches the end of its engineering life, it is expected that a growing number of fires will be caused by electricity asset failures.

The Commission issued eight recommendations for mitigation and management of electricity asset-induced bushfires. These included the replacement, retrofitting and disabling of particular infrastructure components such as single-wire earth return (SWER) powerlines, 22-kilovolt distribution feeders, vibration dampers for long line spans and lines at risk of clashing. Distribution businesses were recommended to review and modify standards and procedures around audit inspectors, with asset inspection standards for SWER powerlines to be reduced to three years. The Commission also recommended that the regulatory framework should require distribution businesses to expand risk assessments for hazardous trees outside standard clearance zones. Finally, it was recommended that Energy Safe Victoria's

[3] Teague *et al.* (2010).

regulatory mandate be strengthened to include preventing and mitigating bushfires caused by electricity assets. Again, the findings of this Royal Commission clearly indicate required changes in the regulatory structure governing electricity transmitters and distributors, to both compel them, and provide them with resources, to undertake more far-reaching and preventative maintenance and risk mitigation.

FINAL REPORT OF THE NSW BUSHFIRE INQUIRY

The NSW Bushfire Inquiry of 2020 also highlighted the critical nature of electricity infrastructure and the capacity for power failures to disrupt the functioning of other essential services.[4] Most telecommunications outages during the 2019-20 Black Summer bushfires were caused by power outages, rather than direct fire damage to communications assets – and those commnications failures clearly exacerbated the dangers faced by those threatened by the fires. The fires caused widespread damage to electricity network infrastructure, including power poles, pole-mounted substation sites, and hundreds of kilometres of overhead high voltage powerlines.

For example, fires burned across 45 per cent of Endeavour Energy's network supply area, damaging and destroying 800 power poles. In Essential Energy's network supply area, over 3,200 poles and 4,500 cross arm poles were damaged or destroyed. Many damanged wooden poles were replaced with new wooden poles (instead of stronger concrete or composite steel alternatives) because of pole shortages and supply issues.

This inquiry raised the possibility of expanding underground networks to minimise service disruptions and increase network resilience – despite underground networks being more expensive to install and difficult for maintenance purposes. It was recommended that telecommunications and electricity network companies update and report on bushfire management plans annually, and that distributors' bushfire preparedness and risk assessment be regularly audited. Again, fulfilling these recommendations will require fundamental adjustments to regulatory practices which currently reflect a persistent bias in favour of constraining preventative and pro-active maintenance and risk mitigation activities.

YORKE PENINSULA FIRE REVIEW

Investigations into the cause of the Yorke Peninsula bushfire on 20 November 2019 attribute the fire to the failure of an overhead 11 kilovolt transformer connection,

[4] NSW Government (2020).

which became disconnected during strong wind conditions.[5] This fire burnt 5,017 hectares, with the loss of many properties and livestock. The Investigation Report showed that SA Power Networks (SAPN) had fulfilled its obligations to complete inspection within the determined five-year cycle; before the fire, a full inspection was last carried out in 2015, followed by a pre-bushfire patrol in June 2019, neither of which identified defects. Although SAPN was not aware of any defects prior to the fire and had maintained its assets in accordance with minimum regulatory procedures, investigations showed that corrosion was evident on the connection lug at fault, and also on other connection lugs in the area. SAPN was instructed to complete internal reviews on lug inspections and review annual Summer Preparation Plans.

This is another example of inadequate inspection capacity and preventative maintenance routines by contributing to an avoidable disaster arising from equipment failure. There is no doubt that the constant downgrading of maintenance budgets arising from the present regulatory regime contributes to the context in which incidents such as this one occur.

SOMMERVILLE REVIEW

The 2004 Sommerville Review of the Queensland electricity network highlighted that power outages caused by asset failure or system overload are preventable, and service delivery can be guaranteed without interruption from these causes so long as sufficient investment is made.[6] Network security can be enhanced by investing in spare assets and spare capacity to manage overloading or switching of load, so that customers can be supplied via alternative assets without interruption. According to the Review, the likelihood of outages caused by asset failure in a well-maintained network with reasonable capacity is very low. But Queensland's transmission and distribution networks at that time had not allocated sufficient expenditure to maintenance, upgrades, and redundancy provisions to ensure reliable and quality service to customers.

ENERGY SECURITY BOARD NATIONAL ENERGY GUARANTEE

The Asset Reliability Improvement Association (ARIA) concluded in its submission to the 2018 COAG Energy Council Energy Guarantee Consultation that assets not being

[5] Government of South Australia (2020).

[6] Independent Panel for Electricity Distribution and Service Delivery for the 21st Century (2004).

maintained adequately pose a major risk to the reliability of electricity supply.[7] The Association also submitted that optimal reliability in the system requires significant investments in excess capacity and redundancy in both generation and transmission, to meet surges in demand and counter disruptions. But the system's capacity to provide these safety cushions is undermined by restrictions on investments and maintenance arising from both competitive pressures and unintended consequences of the regulatory regime:

> "The risk of … failures necessitates additional surplus in generation supply and redundancy in transmission systems to avoid loss of electricity to customers. Surplus in generation and redundancy in transmission by its very nature is very expensive to provide. The lower the level of this surplus in maintaining electricity reliability the lower the average cost to generate and deliver electricity. In turn, this must be balanced against the market forces driving prices for customers higher and increasing the risk of poor reliability when supply is restricted." (p. 2)

While ARIA highlights that the benefits of reducing these risks must be managed against the costs of maintenance, repair and replacement of assets, its submission also highlights that parts of the national grid are in a significant state of decay. As a result Australia suffers from lower reliability, lack of capacity, and high costs of network supply failure.

STATE OF THE ENERGY MARKET 2020

Even the Australian Energy Regulator itself acknowledges that the national energy market faces growing reliability and security challenges due in part to inadequate capacity and capability within the transmission and distribution system. These constraints are becoming more intense as a result of the accelerating transition to renewable and distributed energy supply, which the AER views will pose additional risks to the efficient investment and use of infrastructure.[8] The national market was considered volatile in 2019 due to extreme weather and high system demand, with outages from transmission lines tripping and limiting generation. This volatility continued in the beginning of 2020. But those were not isolated events; a legacy of underinvestment means the whole system is vulnerable to continuing instability in response to a wide range of stressors.

[7] ARIA (2018).
[8] AER (2020).

The AER is clearly influenced by a belief that too much was invested in national electricity networks in the 2000s, in part (it suggests) because of inaccurate energy demand forecasts and overly-stringent reliability standards. This mindset has contributed to its emphasis on reducing operating costs and capital spending within the transmission and distribution systems since then.[9]

In addition, the AER's annual *State of the Energy Market* report for 2020 highlights its particular concern about the efficiency and timeliness of transmission investment lagging behind generation investment. This means that generation projects can be completed without the network being ready for this new capacity to connect. Distribution network security is also a growing concern due to growing rooftop solar PV capacity and other distributed generation sources uptake, requiring the network to manage multidirectional energy flows – with resulting strain on capacity and reliability.

While acknowledging these challenges, the AER's approach to suppressing operating and maintenance expenditures remains inconsistent with the need to resolve these increasingly binding constraints in the capacity and reliability of the grid.

[9] This trend of underutilisation is discussed in further detail in the next section of this report.

III. Statistical Review of Transmission and Distribution Maintenance

INTRODUCTION

This report has provided first-hand qualitative evidence regarding the persistent pattern of underinvestment in maintenance and repair in Australia's electricity transmission and distribution network – and the many consequences of that underinvestment for system reliability, safety, and performance. At a time when more is demanded from the national grid, due to growing population, environmental stresses, and the changing geography of generation (with more dispersed and widely distributed generation capacity, including renewables), less is being allocated to strengthening, upgrading and maintaining it. Those first-hand reports were validated by a review of other published research and public commissions, also attesting to the widespread failure to dedicate adequate resources to the integrity of this essential element of our national infrastructure.

We will now supplement that evidence with empirical data regarding the declining level of investment in the capacity and integrity of Australia's transmission and distribution assets. To this end, we provide three broad sets of data:

1. Evidence from the Australian Energy Regulator on system-wide investments and spending.
2. Evidence from a range of Australian Bureau of Statistics sources regarding investment, employment, and financial performance in the system.
3. Company-specific evidence regarding approved and actual operating expenses in the distribution and transmission components of the grid.

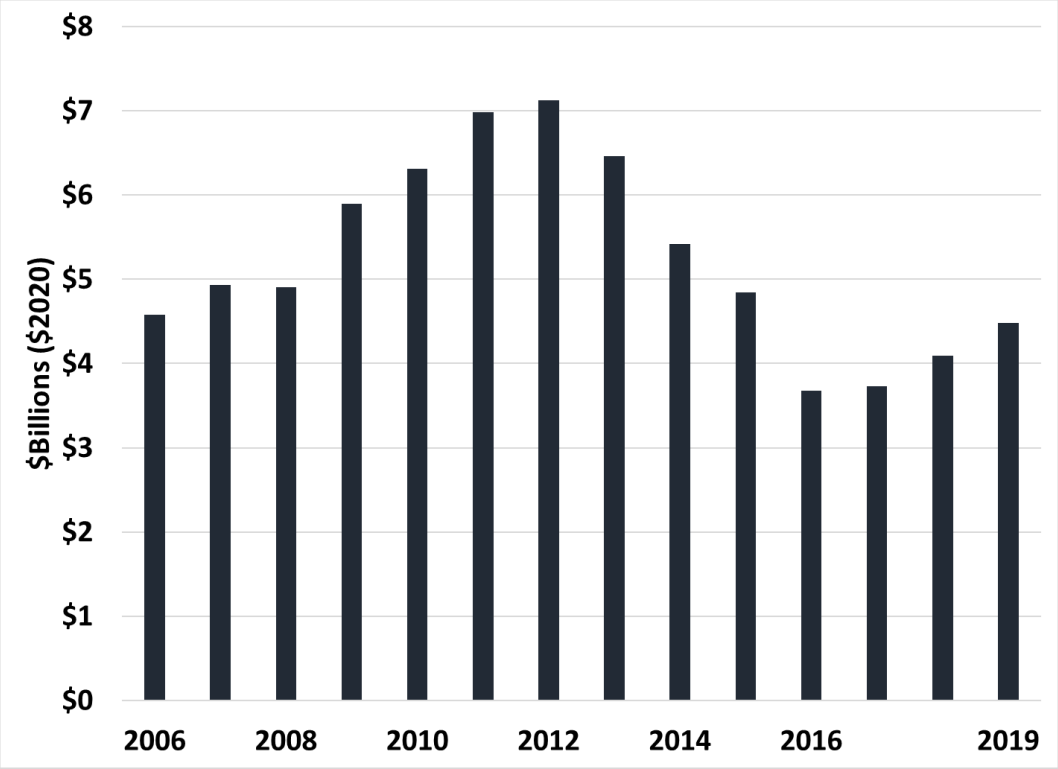
In all cases, the empirical evidence confirms that real activity in maintaining and upgrading Australia's electrical transmission and distribution system has declined in recent years, evn as the demands and stresses on that system have grown.

AER DATA

According to AER statistics, capital spending in the transmission and distribution system rose through the late 2000s, but then declined significantly after 2012 (see

Figure 1). At $4.5 billion, capital spending in 2019 was 37 per cent lower than the $7.1 billion spent in 2012. Those figures are expressed in nominal terms, hence the decline in real investment effort (adjusted for inflation) was even greater.

Figure 1. Annual Capital Expenditure, Transmission and Distribution, 2006-2019



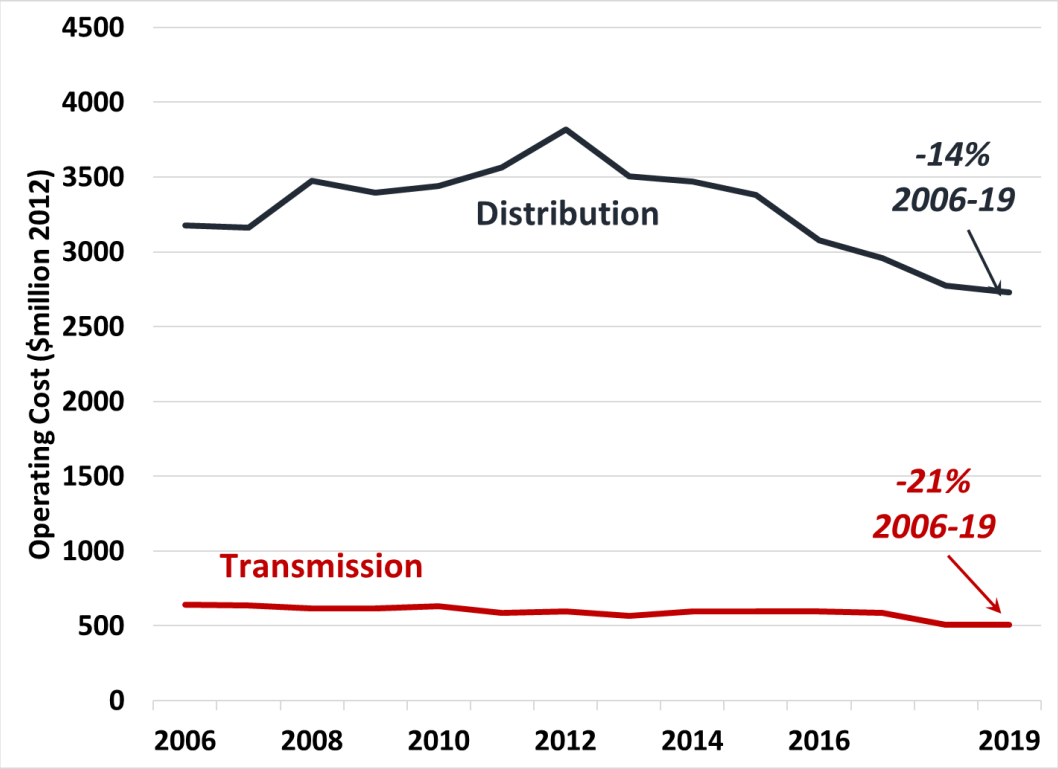
Source: Authors' calculations from AER (2020), Figures 3.25.

In terms of maintenance of the network's capital stock, the AER data does not provide a disaggregation of the industry's operating expenses between physical system maintenance, corporate overhead and administration, finance, and other cost items. Instead, aggregate data is provided only for the overall envelope of operating costs. As will be discussed further below, there is evidence that within that overall envelope, resources have been diverted away from the direct work of operating and maintaining the physical grid, in favour of the growing managerial and financial bureaucracy which now typifies Australia's fragmented and duplicative electricity sector.

Nevertheless, even the trends in aggregate operating costs confirm the downward trend in overall system maintenance. Figure 2 illustrates the trend in aggregate operating costs for the transmission and distribution components of the system, adjusted for inflation (expressed in 2012 dollar terms). Operating expenses in the distribution end of the business first increased until 2012, and then declined notably.

By 2018-19, they were 14 per cent lower in real terms than they had been in 2005-06. Distribution operating costs fell by over $1 billion between 2011-12 and 2018-19.

Figure 2. Operating and Maintenance Expense, 2006-2019

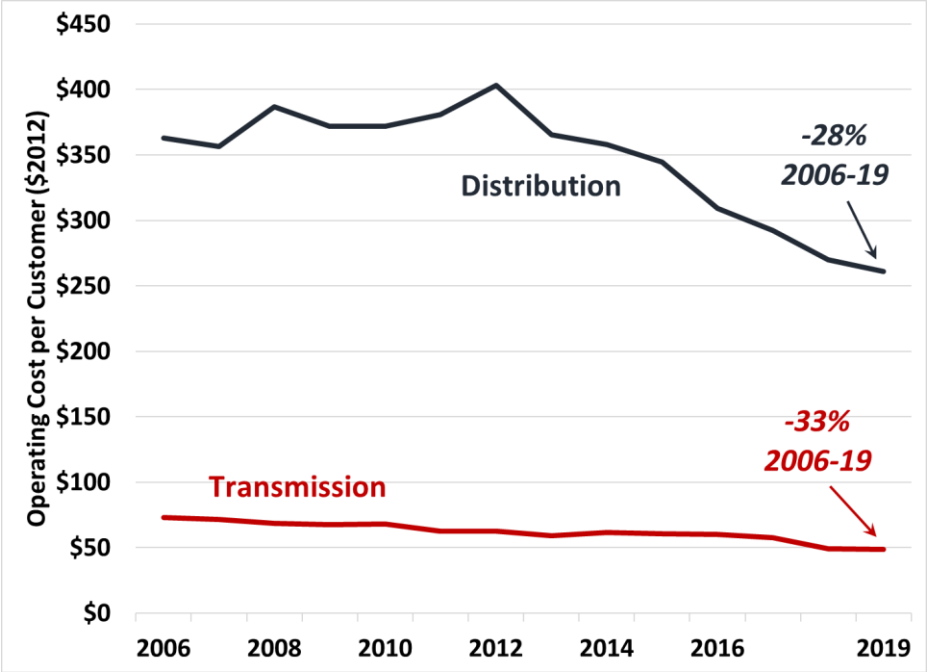


Source: Authors' calculations from AER (2020), Figures 3.22 and 3.23. Financial years ending in indicated year.

In the transmission business, on the other hand, operating costs declined steadily throughout that whole period. By 2019-19, real operating expenses for transmitters were 21 per cent below the level in 2005-06.

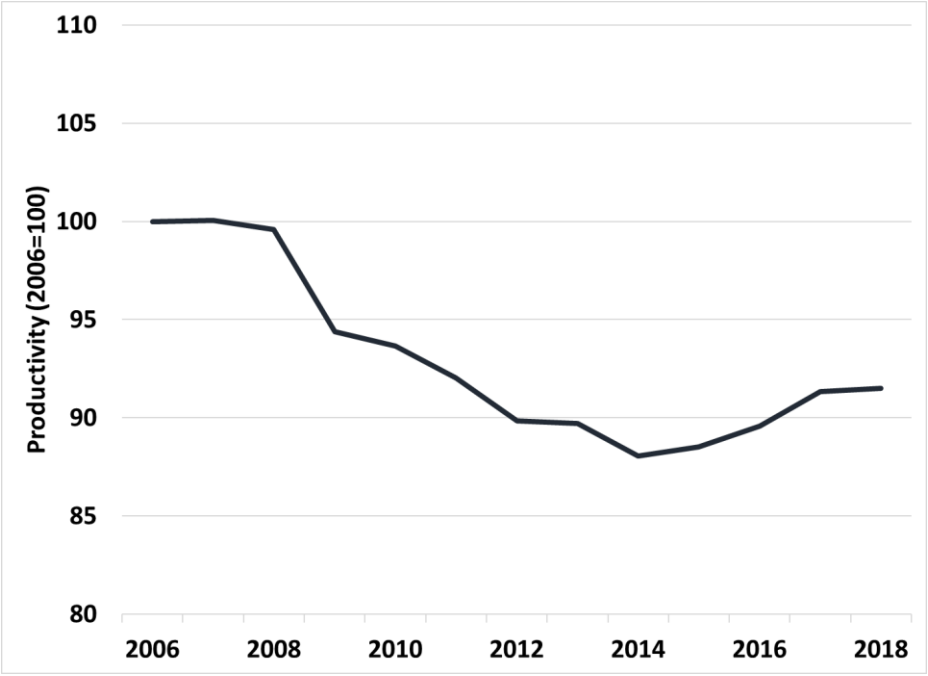
During this period, Australia's population grew relatively rapidly – and so too did the customer base using the electricity system. From the perspective of the fixed capital infrastructure of the electricity grid, the number of customers is a critical determinant of operational requirement – more relevant than the amount of electricity consumed by each customer (which has declined in this period, in part because of very high electricity prices). Adjusted for the increase in the number of customers (which fell by over 10 per cent during this time), real operating costs per customer declined 28 per cent (or over one-quarter) in distribution, and by 33 per cent (or one-third) in transmission (see Figure 3). This is a dramatic indication of the extent of underinvestment in the system's maintenance and repair.

Figure 3. Operating and Maintenance Expense per Customer, 2006-2019



Source: Authors' calculations from AER (2020), Figures 3.22 and 3.23. Financial years ending in indicated year.

Figure 4. Total Factor Productivity, AER Estimates, 2006-2018



Source: Author's calculations from AER (2020), Figure 3.24. Multilateral total factor productivity indices; unweighted average of transmission and distribution networks by state.

Figure 4 illustrates the downward trend in the AER's preferred measure of productivity: a constructed index of multilateral total factor productivity. On average across 14 distribution and transmission companies, it has declined by close to 10 per cent since 2005-06. Other measures of productivity (such as labour productivity, considered below) suggest an even steeper decline in the fundamental operating efficiency of the system. The fact that the AER itself acknowledges the failure of the current competitive and regulatory regime to promote true improvements in efficiency, combined with evidence (also presented below) of soaring prices paid by consumers, is surely a strong indicator that the fundamental operation of this regulatory regime is deeply flawed and needs to be reconsidered.

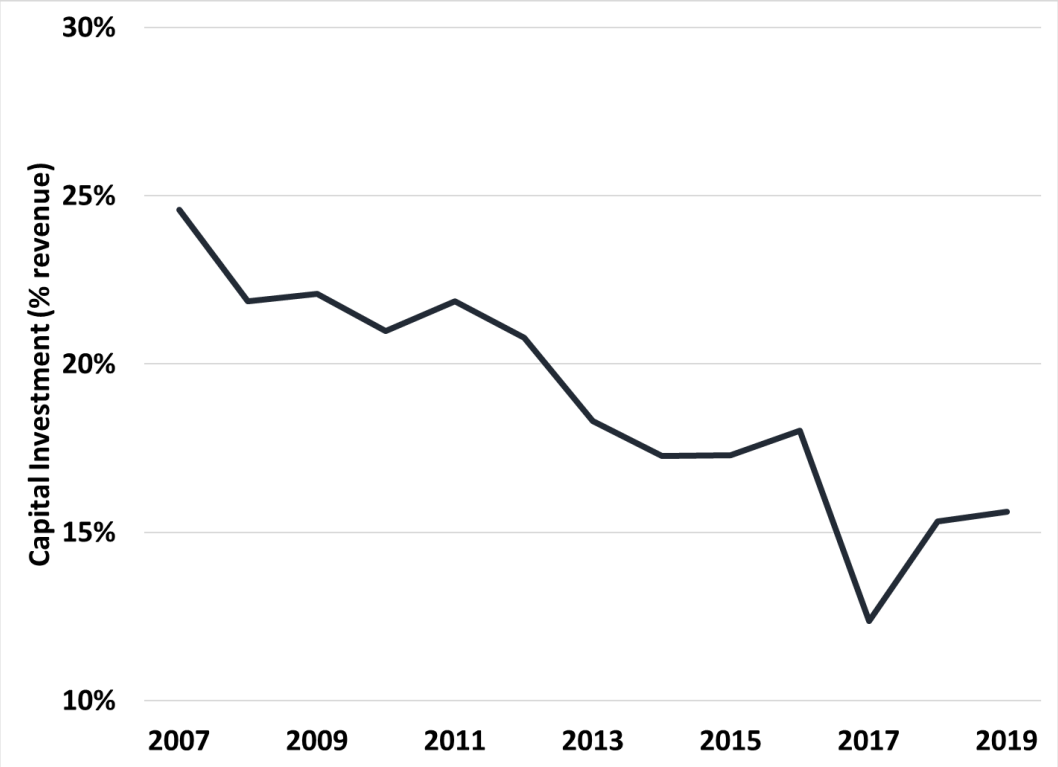
ABS DATA

The Australian Bureau of Statistics produces regular statistics on a number of economic indicators of relevance to the electricity industry. In some cases, these data are available only for the electricity industry as a whole (including the generation sector). In other cases, we are able to disaggregate the transmission and distribution components, our major interest in this paper. These ABS series round out and confirm the perspective provided by our qualitative research and AER statistics: namely that declining attention has been paid to the quality and reliability of the real capital assets underpinning the transmission and distribution system.

The ABS provides broad financial indicators for the combined electricity industry, including revenues, labour costs, profits, and capital spending, on a financial-year basis. We present selected indicators of the shifting emphasis of the industry over the past dozen years.

Figure 5 illustrates the downward trend in capital spending in the sector, relative to the industry's annual revenue base. Nominal capital spending in the overall electricity sector has grown at an average annual rate of 3% since 2006-07 – barely keeping up with inflation, so largely stagnant in real terms. As noted above, with reference to AER data, capital spending in the transmission and distribution components of the industry has declined markedly in recent years; investments in new generation capacity have been the major source of new capital spending in recent years. Relative to the surging revenues collected from electricity consumers, the combined electricity industry's capital spending has fallen by two-fifths: from 25 cents out of each dollar of revenue in 2006-07, to around 15 cents in recent years.

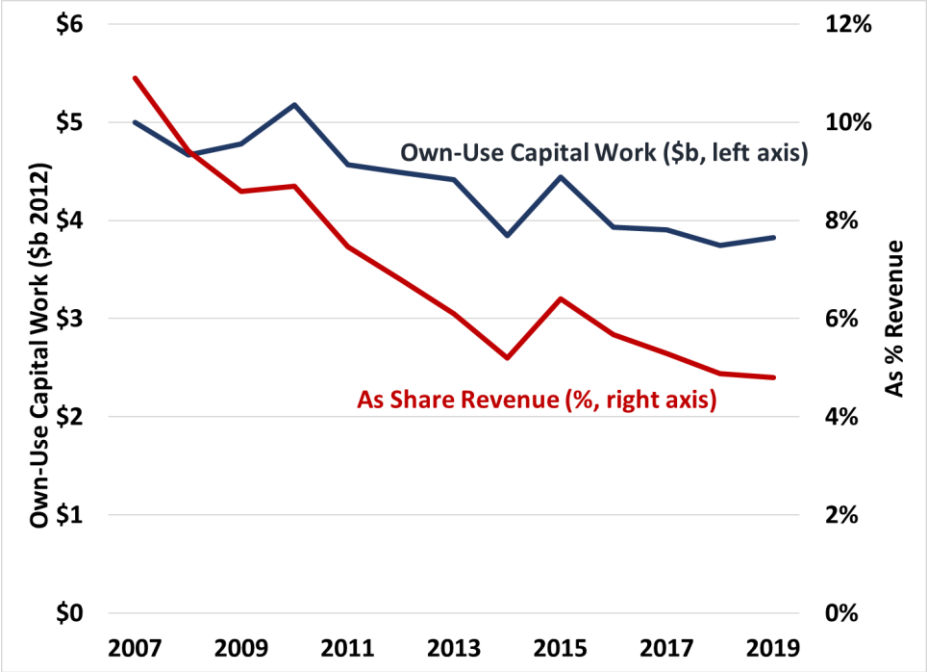
Figure 5. Capital Investment, Electricity Industry, 2007-2019



Source: Authors' calculations from ABS, Australian Industry, Industry by Subdivision, Table 4.

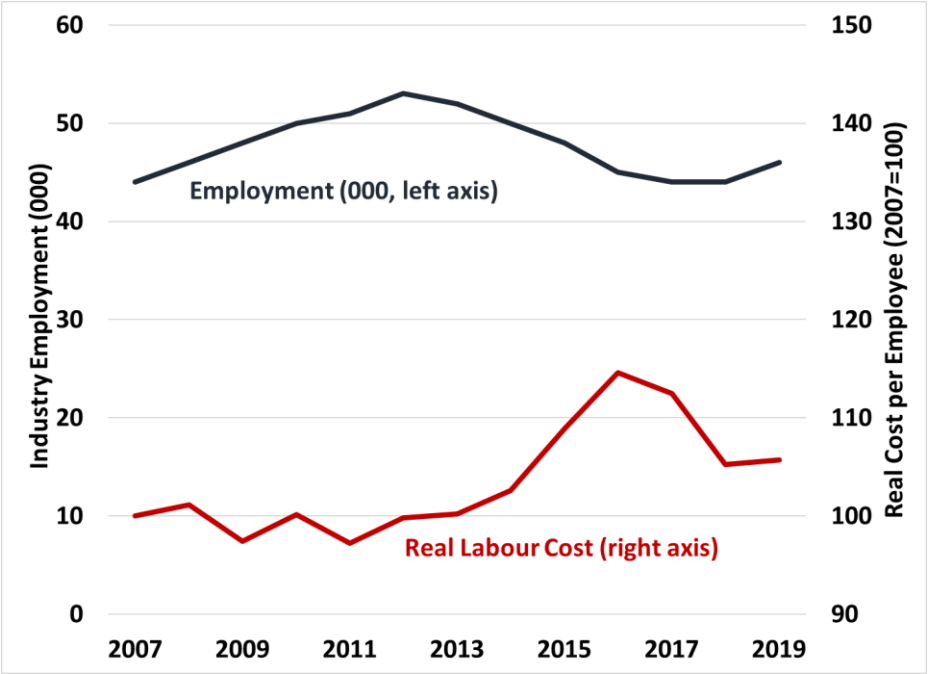
The ABS business indicators data does not provide a breakdown of maintenance expenditures within the system. But it does report one variable which can be interpreted as a decent proxy for internal installation and maintenance activity by the industry. It reports a variable termed 'capital work done for own use', which refers to capitalised work undertaken by companies related to the construction, installation, and repair of capital assets. This will include much maintenance work on equipment and networks, as well as installations of new equipment. This internal capital work has been stagnant over the entire period covered by this data: at around $4 billion (nominal) per year. Capital work for own use has thus declined by over one-fifth in real terms (as indicated in Figure 6), and more dramatically as a share of the industry's total revenues. As of 2019, less than 5 cents from each dollar of revenue collected by the electricity industry was devoted to the installation, maintenance, repair and upgrading of the industry's capital stock (including the transmission and distribution networks). That was less than one-half the own-use capital intensity demonstrated by the industry in 2006-07, when it allocated over ten cents of each dollar to the same types of work. This confirms the eroding commitment of the industry to the modernization and maintenance of its capital stock.

Figure 6. Own-Use Capital Work, Electricity Industry, 2007-2019



Source: Authors' calculations from ABS, Australian Industry, Industry by Subdivision, Table 3, and Consumer Price Index, Table 1.

Figure 7. Employment and Labour Costs, Electricity Industry, 2007-2019

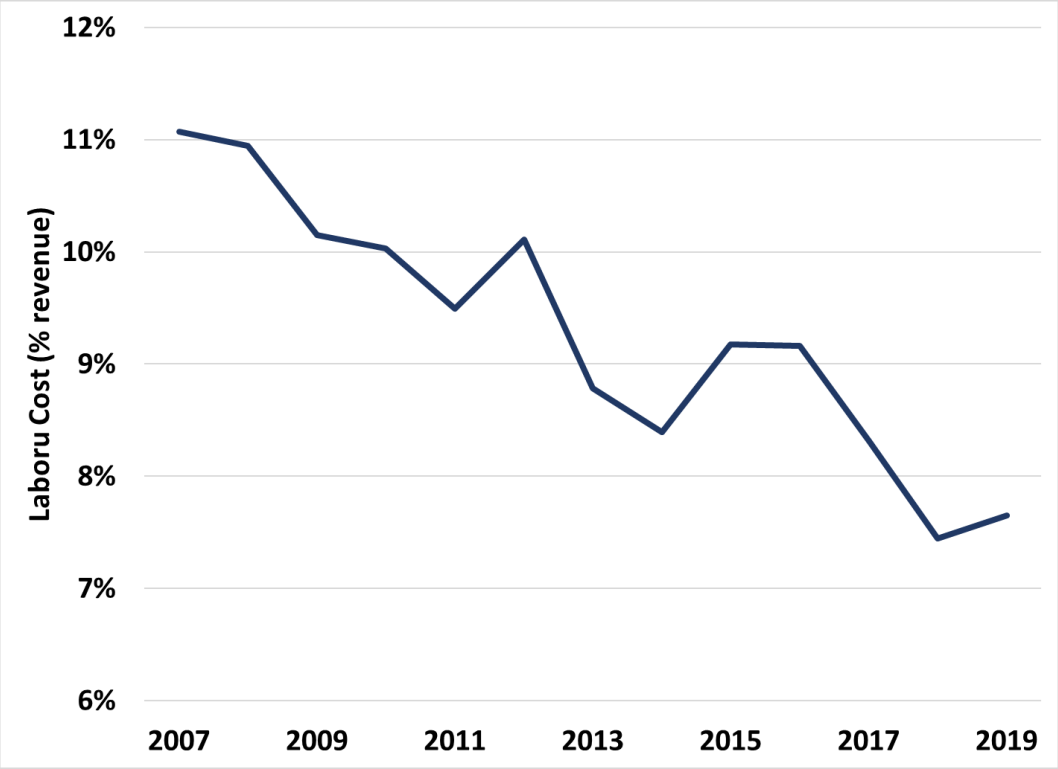


Source: Authors' calculations from ABS, Australian Industry, Industry by Subdivision, Tables 2 and 4, and Consumer Price Index, Table 1.

Employment in the overall electricity sector has declined significantly since 2012, as illustrated in Figure 7. (Specific data for employment in transmission and distribution is not available from this annual ABS source; below we report some disaggregated employment data from the five-yearly census.) The broader industry shed almost 10,000 jobs between 2012 and 2017, before conducting modest new hiring in 2018-19.

Labour costs per employee in the broader electricity sector are not much higher (in real terms) than they were a dozen years ago. Wages and other labour costs increased temporarily in the mid-2010s – in part because of strong labour market conditions for skilled trades workers. But labour costs have been retrenched since then. Adjusted for inflation, real labour costs per worker in 2018-19 were just 5 per cent higher than in 2006-07 (Figure 7), implying an annual rate of real wage growth of less than one-half percentage point per year.

Figure 8. Labour Costs as Share Revenue, Electricity Industries, 2007-2019



Source: Authors' calculations from ABS, Australian Industry, Industry by Subdivision, Table 2.

The combination of falling staff headcounts, stagnant real wages, and surging revenues (from higher electricity prices) has produced a dramatic and sustained decline in the relative importance of labour costs in the industry's overall cost structure. As illustrated in Figure 8, labour made up just 7.6 per cent of total revenues in 2018-19,

down from 11.1 per cent in 2006-07. This indicates the suppression of general staff and operating costs, and the shifting focus of the industry away from concrete service delivery toward marketing, re-selling, and financial activity. Moreover, as will be documented below, a growing proportion of those total labour costs are associated with corporate overhead functions rather than direct work associated with production and delivery of power.

Figures 7 and 8 described employment and compensation trends in the overall electricity sector (including generation, transmission, distribution, and related activities). As noted, annual ABS data sources do not allow a disaggregation of those totals across the various sub-sectors of electricity. However, ABS census data (collected every 5 years) provide greater detail on the precise sectoral and occupational composition of the electricity industry workforce.

As of the 2016 census, some 27,000 Australians indicated they were employed in electricity transmission, distribution, and related activities. This implies that around 60 per cent of total electricity industry employment is in the transmission and distribution end of the business. However, that 27,000 headcount represented a loss of over 3600 positions in the previous five years (going back to the 2011 census) – equivalent to a 12 percent reduction in staffing over that 5-year period. The loss of work in transmission and distribution since 2011 offset most of the growth in employment that occurred in the 2000s.

The simple total of employment in the industry is not a good indicator, however, of the allocation of real resources by companies in transmission and distribution to maintaining the industry's infrastructure in top, reliable condition. This is because the fragmented, financialised nature of the industry since privatisation and deregulation has resulted in the reallocation of resources away from direct service provision (including upkeep and maintenance) in favour of a wide range of overhead, management, sales, and bureaucratic functions.

By examining the occupational make-up of the transmission and distribution workforce, we can 'drill down' to isolate the proportion of the industry's overall staff resources who are gainfully employed in the actual work of 'keeping the lights on' – and thus evaluate whether that real maintenance function is rising or falling. Our previous research[10] indicated that a growing share of the workforce in the overall electricity sector has been assigned to occupations not directly associated with producing electrical services: including management, finance, and sales. Employment of sales workers grew almost 400% in the 20 years ending in 2016; employment of

[10] See Richardson (2019).

managers increased over 200%. And the ratio of managers to production workers more than doubled in that period.

Here we perform a similar analysis of census data for the transmission and distribution sectors, in particular, to ascertain the distribution of the workforce across various occupations. This analysis confirms that the regulatory and competitive structure of the industry has been shifting scarce resources away from the direct provision of concrete services, in favour of corporate overhead functions, management, and financial churning.

Table 1
Main Occupations, Electricity Transmission and Distribution

	2006	2011	2016	Change, 2006-16 (%)
Managers	2,554	3,648	3,473	36.0
Professionals	4,966	6,947	6,767	36.3
Technicians & Trades	10,933	13,131	11,081	1.4
Of which: Electricians[1]	*7,385*	*8,951*	*7,295*	*-1.2*
Clerical	4,837	5,204	4,222	-12.7
Unskilled	1,726	1,872	1,653	-4.2
Total	25,016	30,802	27,196	8.7

Source: Author's calculations from ABS Census data.

1. Including Electricians, Electronics and Telecommunications Trades Workers nfd, Electrical Distribution Trades Workers, Electronics Trades Workers, Electrical Engineering Draftspersons and Technicians, Electronic Engineering Draftspersons and Technicians, Electrical Engineers, and Electronics Engineers

Table 1 decomposes total employment in the transmission and distribution sectors into broad occupational categories. Immediately noteworthy is the high proportion of employment in administrative positions: including managers, professionals and clerical workers. Those three groups account for 53.4 per cent of the total workforce.

Some of the positions involved in these various overhead and bureaucratic functions are surprising. Appendix A provides a complete list of all the occupations represented in the electricity transmission and distribution industries. It highlights significant employment in a number of occupations that are certainly not directly related to the core operation of an electricity system. This includes 191 personal assistants, 66 gardeners, 44 chief executives, 39 debt collectors, 27 authors and journalists, 112 advertising and marketing professionals, 73 public relations professionals, and 40 economists. Many of these positions were clearly unnecessary under the electricity

industry's previous structure, in which electricity was supplied as a public service – not a competitive commodity – and when generation, transmission, distribution and sales functions were all consolidated under one roof.

The increasingly top-heavy, bureaucratic structure of the industry is evident from an analysis of the changing composition of the workforce over time. Total employment in the transmission and distribution sectors increased modestly in the decade ending in 2016 (the most recent census year), by a cumulative total of 8.7 per cent. That includes a stronger increase in employment from 2006 to 2011, followed by a significant reduction in employment since then. However, as indicated in Table 1, the occupational distribution of the workforce changed markedly within that modest increase in total employment.

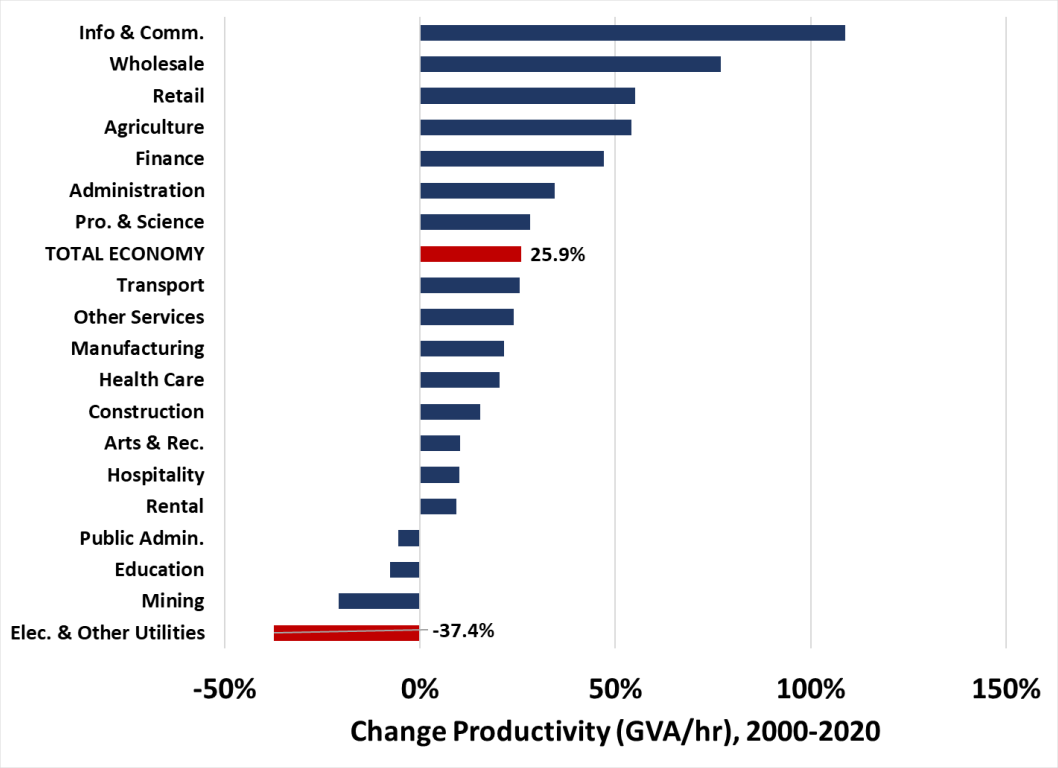
In the decade ending in 2016, the number of managers employed in transmission and distribution grew by a very strong 36 per cent. The number of professionals grew by an equivalent proportion. Clerical and unskilled workers were downsized over this period. Overall employment of technical and trades workers was stagnant in this period: growing by just 1 per cent over the decade. And employment of electricians and related trades actually declined over the same period (by just over 1 percent). More recently, in the five years from 2011 through 2016, employment of electricians and related specializations declined by 1650 positions (or 19 per cent). As of 2016, electricians and related staff accounted for just 27% of total employment in the transmission and distribution sector. That year there were 40% more managers and professionals working in the transmission and distribution industry, than electricians.

The sheer cost of corporate overhead, management, and bureaucracy, duplicated across competing suppliers, has dragged down genuine efficiency in the electricity transmission and distribution sector. The AER's own data, cited above, acknowledges that productivity (measured in multi-factor terms) has declined steadily despite the supposed benefits of market-driven competition and efficiency. Complementary ABS data sources confirm this erosion in basic efficiency, coincident with the misallocation of resources in the industry away from core functions (including maintenance and reliability) and toward overhead and administrative functions which are not directly productive.

Indeed, core productivity in the electricity sector has performed worse than any other major industry in Australia over the last two decades, as the industry was privatized, and the current structure of overlapping corporate interests established. Figure 9 illustrates the cumulative change in labour productivity (measured by gross value added per hour worked) for all major sectors in Australia (defined at the 2-digit level of disaggregation). Labour productivity in the amalgamated utilities sector (including gas,

water, and waste services – but dominated by the larger electricity industry) declined by a shocking 37 per cent over those two decades. It should be stressed that this erosion of fundamental efficiency does not reflect any lack of skills or discipline on the part of the directly skilled workforce in the sector. It is the result, rather, of the construction of an enormous edifice of unproductive and duplicative corporate bureaucracies, and the diversion of the industry's primary attention away from supplying affordable, reliable power in favour of marketing, speculation, and sales.

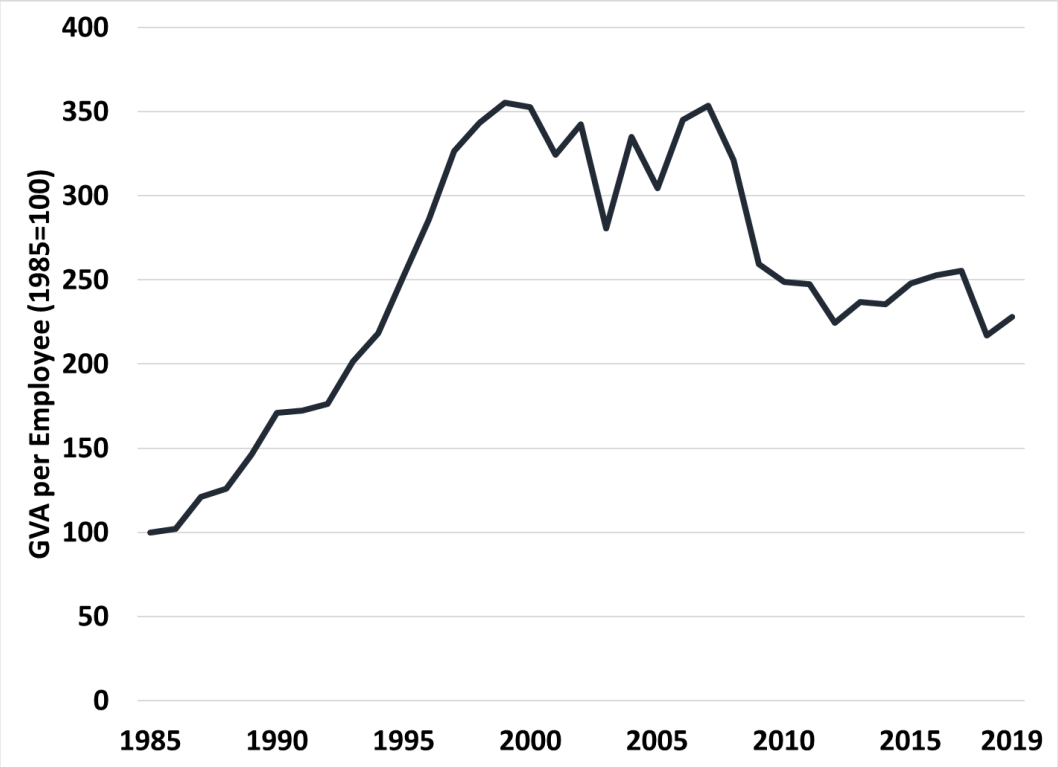
Figure 9. Productivity Growth by Industry, 2000-2020



Source: Authors' calculations from ABS National Accounts, Table 15, financial years.

A similarly bleak picture of the industry's flagging efficiency, in real productive terms, is provided in Figure 10, which isolates labour productivity trends in the electricity industry alone. This figure measures gross value added in the overall electricity sector (including generation, transmission and distribution) per employee. Productivity grew steadily from 1985 through the turn of the century on the strength of technological improvements, upskilling of the workforce, and capital investment. By the turn of the century, real output per worker was 3.5 times higher than in 1985.

Figure 10. Productivity Growth, Electricity Industry, 1985-2019



Source: Authors' calculations from ABS, Detailed Labour Force and National Accounts data.

With the onset of privatisation and fragmentation, however, productivity plateaued. And with the onset of the Global Financial Crisis in 2008, productivity began to markedly decline. By 2019, productivity had declined by one-third relative to 2007 levels.[11] In addition to the deadweight cost of unproductive corporate bureauracy, sales churning, and rent-seeking, productivity performance was further hampered by the industry's growing use of part-time, insecure labour,[12] and the decline of overall electricity volumes (resulting in redued capacity utilisation).

The misdirection of the industry's focus away from the real work of supplying reliable, affordable power, to selling and re-selling, financial schemes, and other unproductive activities, can be further confirmed with an analysis of ABS data regarding the input-output linkages in the transmission and distribution industry. Each year the ABS

[11] This is compatible with the productivity changes reported in Figure 9 for the entire utilities sector – confirming that that trend was indeed driven by the deterioration of productivity in the electricity industry.

[12] By 2019, as many as 12 per cent of total employment in the electricity sector was part-time, compared to less than 2 per cent in 1985. Growing reliance on insecure, part-time labour reduces output per person. Author's calculations from ABS Detailed Labour Force data.

produces a comprehensive set of data describing the interrelationships between any Australian industry and its supply chain: that is, all the various sectors that supply that industry with inputs of raw materials, semi-finished goods, manufactures and equipment, and services. These input-output tables provide a detailed snapshot of the fundamental methods through which each industry produces its output. Table 2 summarises the input-output structure of the electricity transmission and distribution sectors,[13] comparing financial year 2006-07 with 2017-18 (the most recent year for which this data is available).

Table 2
Composition of Gross Output and Value Added, Electricity Transmission and Distribution

Component	Flows ($ bil.)			Shares[1] (%)		
	2006-07	2017-18	Change (%)	2006-07	2017-18	Change (% pts)
Materials & Equipmt.	1.171	1.227	4.8%	7.2%	2.3%	-4.9%
Electricity Own-Sales	3.287	21.602	557.2%	20.1%	40.0%	19.9%
Construction	1.269	2.296	80.9%	7.8%	4.3%	-3.5%
Finance	0.878	3.719	323.6%	5.4%	6.9%	1.5%
Other Services	1.918	3.399	77.2%	11.7%	6.3%	-5.4%
Total Intermediate Purchases	**8.523**	**32.243**	**278.3%**	**52.2%**	**59.8%**	**7.6%**
Labour Compensation	3.396	5.061	49.0%	20.8%	9.4%	-11.4%
Gross Op'g Surplus	4.115	12.873	212.8%	25.2%	23.9%	-1.3%
Taxes less Subsidies	0.300	3.762	1154%	1.8%	7.0%	5.1%
Total Value-Added	**7.803**	**21.676**	**177.8%**	**47.8%**	**40.2%**	**-7.6%**
Total Output	**16.334**	**53.939**	**230.2%**	**100.0%**	**100.0%**	

Source: Authors' calculations from ABS Australian National Accounts: Input-Output Tables, Table 2.
1. Shares of total output.

The results of this analysis are telling. The left side of Table 2 reports inputs and outputs in nominal dollars for each year. The total nominal value of output produced in the combined transmission and distribution sectors more than tripled over the 11-year period considered: from $16 billion in 2006-07 to almost $54 billion in 2017-18. However, that escalation of nominal production did not remotely reflect an increase in the supply of actual electricity: shockingly, the real value-added by the entire electricity sector grew by only 2.6% over that same period. The escalation of nominal

[13] Table 2 also includes on-selling and market operation functions.

revenues overwhelmingly reflected an enormous inflation of electricity prices (described further below), driven by corporate behaviour that emphasized rent-seeking rather than real improvements in service.

Corporate profits during this period also more than tripled: with gross operating surpluses swelling from $4 billion in 2006-07 to almost $13 billion in 2017-18. As a share of (artificially) inflating nominal revenues, corporate profits held steady (at around one-quarter of total sales); but that steady share of a rapidly inflating 'pie' nevertheless translated into enormous increases in profits (as reported above). These increases in profit have clearly come at the expense of electricity consumers. The disprove claims that privatisation, corporatisation and marketisation produce efficiency dividends that ultimately benefit consumers. This profit increase is incredible given the near-zero growth in electricity use over this period.

In the same time, however, the share of total revenue going to workers in the industry was cut more than in half: from over 20 per cent in 2006-07, to just 9.4 per cent by 2017-18. Less than 10 cents of each dollar in electricity revenue, therefore, is paid to the people who actually operate the system – and, as noted above, a shrinking share of that workforce (only 27% as of 2016) consists of people actually servicing the network. Corporate profits grew more than 4 times as fast as wages and salaries between 2006-07 and 2017-18.

But even the startling contrast between profits and wages does not tell the full story of the unproductive, financialized mode of behaviour which has been imparted to Australia's electricity industry under its current mode of ownership and regulation. Other details in Table 2 attest further to the enormous misallocation of resources and attention away from reliable delivery of an essential service, toward self-dealing, financial shell games. The top portion of Table 2 reports the broad categories of inputs which the transmission and distribution industry purchased in the course of its production each year. This includes physical inputs (such as raw materials, parts, and equipment), and construction. The industry also purchases a wide range of services – the most important of which are now various financial services (including banking, auxiliary financial services, insurance, and more).

Purchases of 'real' inputs (materials and equipment) diminished in relative and real terms over this period: growing less than 5% in nominal terms over that 11-year period (and hence shrinking in real quantity terms). As a proportion of the sector's total output, these real inputs declined dramatically: from 7 per cent of revenues to just 2 per cent in 2017-18. The share of revenues dedicated to construction also shrank, from almost 8 per cent to just over 4 per cent. Purchases of financial services became dramatically more important: more than tripling, to $3.7 billion in 2018-18, equal to 7

per cent of all system revenues. Remember, aggregate wages and salaries in the industry (including for the swollen management system) account for only 9 per cent of system revenues. So this hyper-financialised industry now pays almost as much to bankers, as it does to the industry's own workforce. The transmission and distribution sector now spends more on financial services, than on purchases of real inputs, machinery, and construction combined. This is a dramatic indication of how the industry's attention and focus has been badly misdirected away from what should be its fundamental goal: delivering reliable, affordable electricity to Australian customers.

By far the biggest category of input purchases by the transmission and distribution sector, however, has now become self-dealing with other businesses in the same industry. In 2017-18, the sector spent an astounding $21.6 billion buying services from other electricity companies – eating up 40% of the industry's total revenue. A full 99 percent of that was purchased from other transmission and distribution businesses; a mere $265 million worth of inputs was purchased from the generation sector.[14] This testifies to a tremendous fragmentation, whereby different segments of the industry purchase services from each other. This in turn requires an enormous corporate overhead to conduct, account for, and manage these intra-industry transactions. This fragmentation, duplication, and waste confirms the irrationality of the industry's present ownership and regulatory structure. The AER's self-styled discipline in cracking down on corporate costs and driving efficiency gains has absolutely backfired: the industry is dominated by pointless and wasteful financialisation, self-dealing, and rent-seeking. A shrinking share of real resources and management attention is dedicated to what should be the overarching function of the system: delivering reliable, affordable electricity.

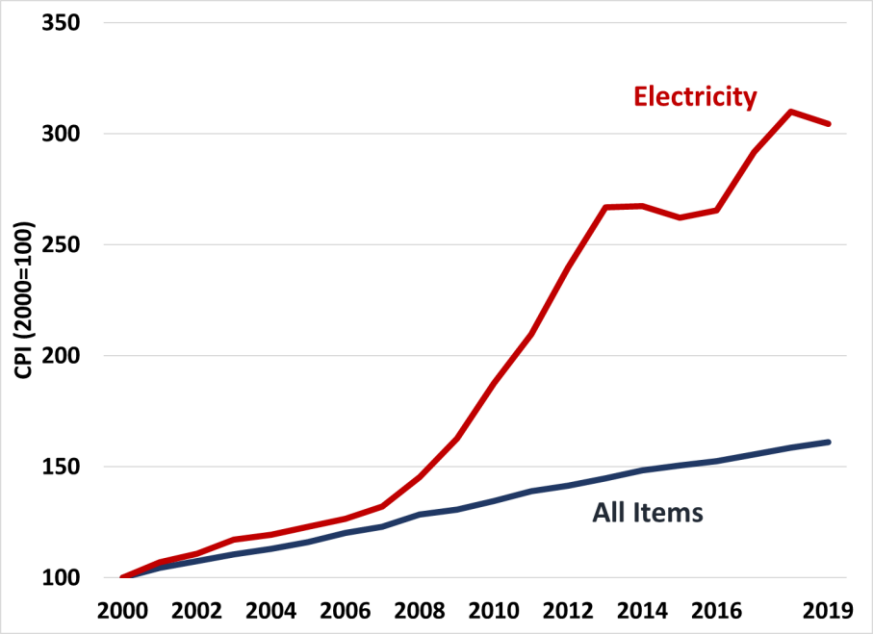
It is obvious that consumers have not benefited from the pseudo-competitive structure of the industry. Prices for delivered electricity have skyrocketd since the mid-2000s, surging much faster than other prices in the economy. Considering the vast waste of resources on overlapping corporate overheads and management, this is not surprising.

Figure 11 reveals the trend in consumer price indices for electricity, in comparison to the weighted average CPI for all items, based on ABS data. Residential electricity prices have tripled since the turn of the century – growing more than three imes faster than the overall level of consumer prices (which rose 60 per cent over the same 20-year

[14] In the ABS's input-output accounting, the transmission and distribution sectors are paid solely for transporting the electricity, not for its production; hence the value of the electricity itself is not included in transmission and distribution costs and revenues.

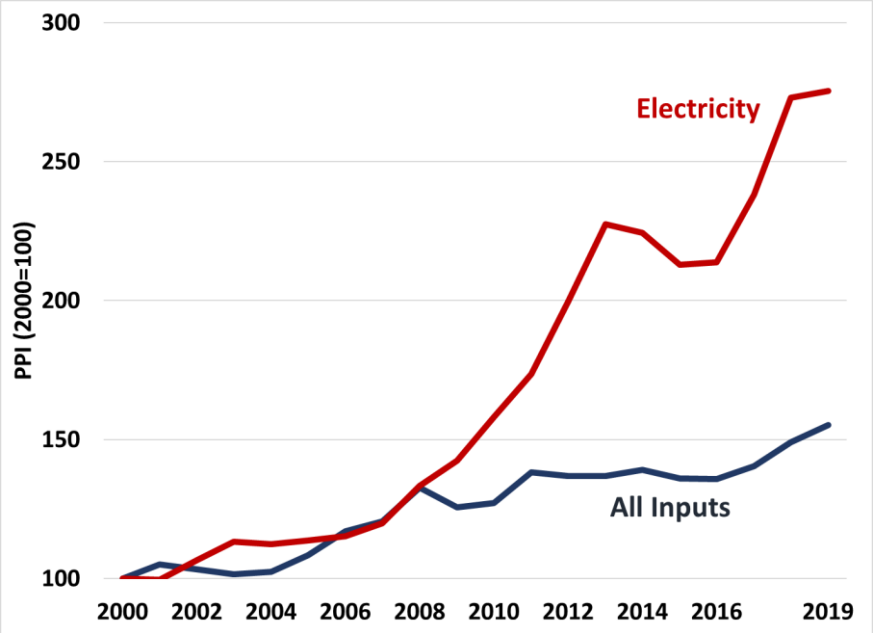
period). In real terms (that is, in comparison to overall consumer prices), electricity prices for individual consumers have increased by 90 per cent.

Figure 11. Consumer Prices, Electricity, 2000-2019



Source: Authors' calculations from ABS, Consumer Price Index, Table 7.

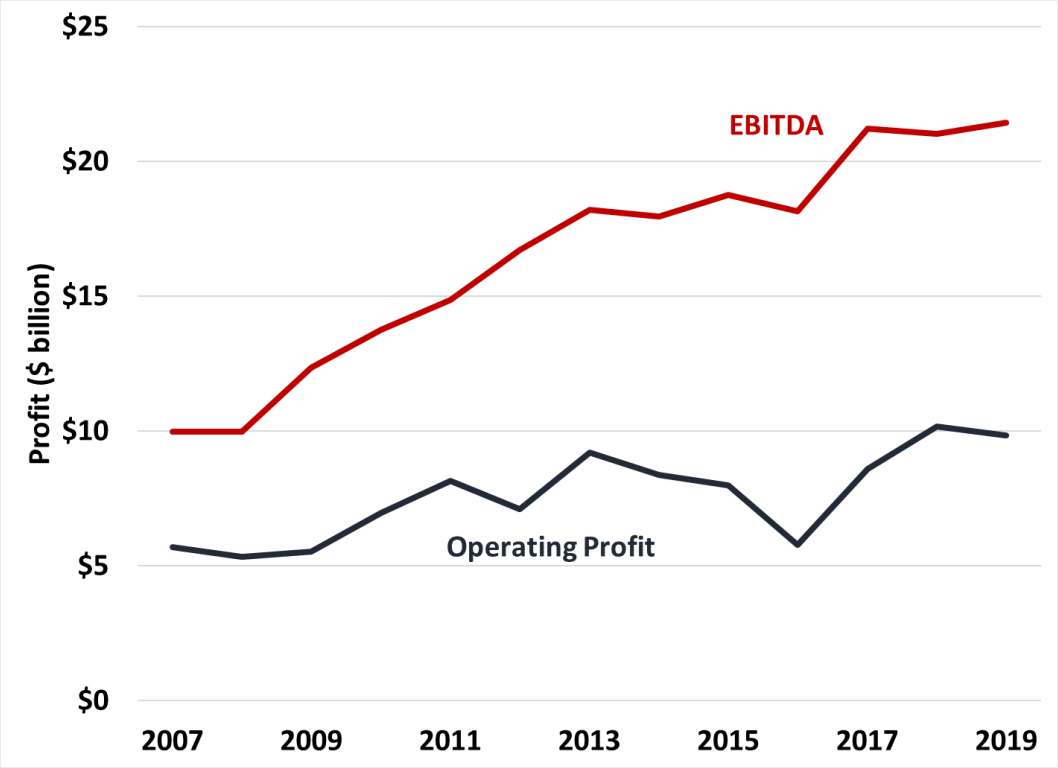
Figure 12. Input Prices to Manufacturing, 2000-2019



Source: Authors' calculations from ABS, Producer Price Indexes, Table 13. Manufacturing purchases.

Industrial users of electricity have not fared much better. For example, Figure 12 illustrates the trend in input prices for electricity purchases by Australian manufacturing businesses. Prices have almost tripled since 2000, compared to an increase of just over 50 per cent in the overall level of input csots for manufacturing.

Figure 13. Measures of Profitability, Electricity System, 2007-2019



Source: Authors' calculations from ABS, Australian Industry, Industry by Subdivision, Table 1.

Despite stagnant demand and the costs of duplicated corporate overhead and bureaucracy, profits in the electricity industry have been very strong. Figure 13 indicates the growth of two key measures of profitability in the broader electricity sector: earnings before interest, tax, depreciation and amortisation (red line) and before-tax operating profits (blue line). Both measures of profit doubled in nominal terms over the past decade. Suppressing labour costs (in real per-employee terms and as a share of total revenues) and charging higher prices to customers have allowed energy companies to pocket growing profits despite the fundamental inefficiency and waste of the industry's present structure.

These statistical indicators confirm that the industry is allocating less resources to capitalizing and maintaining the industry's real capital stock. It spends more money on finance than on real inputs to transmission and distribution. It hires more managers

and professionals than electrical trades workers. Its capital and maintenance expenses have been squeezed. The end result for workers has been reduced employment and reduced real compensation. The end result for consumers has been skyrocketing prices and unacceptable levels of service reliability. The whole system, despite the AER's pretenses of enforcing competitive 'discipline' on market players (including by adding to downward pressure on maintenance budgets through its tight-fisted determinations), has facilitated an enormous transfer of wealth from workers and consumers, to owners, financiers, and managers.

COMPANY LEVEL DATA: DISTRIBUTORS

The AER in its interactions with regulated companies generates data regarding the operational and financial performance of individual companies. When making regulatory determinations regarding prices, allowable profit, and other benchmarks, the AER considers a variety of factors including operating expenditure. The regulator sets allowable ceilings for operating expenditure consistent with its expectations regarding sales volumes, efficiency, and rate of return. However, companies are provided an incentive to reduce operating expenses below the thresholds determined by the regulator. Under the AER's Efficiency Benefit Sharing Scheme (EBSS), if operating costs come in under the forecast in the regulatory determination, energy companies are allowed to keep some of the savings in the form of extra profit.

This regulatory system thus establishes a two-fold downward pressure on operating and maintenance expenditures in the transmission and distribution system. First, the regulator tries to suppress these costs, on the (false) assumption that squeezing operating costs will ultimately produce savings for consumers. This assumption is invalid: both because inadequate maintenance spending can actually result in higher costs in the future (as a result of preventable failures and breakdowns), and because the wasteful and duplicated costs of corporate overhead resulting from the irrational and fragmented structure of the industry drive up final prices for consumers anyway.

Second, on top of this inefficient process, individual companies are given a strong financial motivation to suppress maintenance budgets even further below the stringent levels established by the AER. This profit-seeking does not result in lower prices for consumers – it only further endangers the integrity and reliability of the network.

This two-sided 'race to the bottom' pattern is readily visible in company-level data and determinations from the AER. Below we provide a sample of evidence from a range of company-level determinations confirming the ongoing suppression of maintenance

and operating expenses. As indicated above, this is not proof of the 'efficiency' of the system – which has become steadily less productive over time, according to several core measures. Nor has it resulted in lower electricity prices for consumers.

Victorian Determinations

The AER has just completed a round of draft determinations regarding the distribution network in Victoria. Its draft determinations provide a useful insight into the shell game which the regulator and the companies play, in each round of regulatory scrutiny. The AER claims it is being rigorous in suppressing costs and driving 'efficiency'. Yet the distrbutors are miraculously able to beat the AER-approved thresholds virtually every year, delivering extra profit to their owners. Meanwhile, prices to consumers stay at inflated levels, and the actual work of maintenance and upgrading of the network is neglected.

AusNet[15]**:** AusNet has consistently been underspending relative to AER forecasts of appropriate levels of operational and maintenance spending. As reported in the AER's most recent draft determination for this company (see p. 39), AusNet has suppressed operating expenses more than $50 million per annum below the AER's approved forecasts. And from a peak in 2016 of over $250 million, actual operating spending has declined by $50 million.[16]

As discussed above, a major feature of the existing regulatory regime is the use of various incentives to attain supposed 'efficiencies'. In its discussion of AusNet operations, the AER described this strategy as follows:

> "Incentive schemes are a component of incentive based regulation and complement our approach to assessing efficient costs. These schemes provide important balancing incentives under the revenue determination … to encourage AusNet Services to pursue expenditure efficiencies and demand side alternatives while maintaining the reliability and overall performance of its network."[17]

If anything, the regulator seems pleased that actual operating expenditures fall consistently below the approved levels, and knowingly allows this excess cushion to

[15] AER (2020) AusNet Services Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20AusNet%20Services%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020.pdf

[16] Estimated from AER figures. Note that all dollar figures expressed in AER determinations are in real terms, but with varying base years chosen.

[17] AER (2020) AusNet Services Distribution Determination 2021 to 2026

extend into the future. The AER acknowledges (p. 38) that its draft decision would allow for operating expenses more than 5 per cent higher than what the company was actually spending – thus ensuring the continuation of this misleading 'overachievement' (with resulting benefits for AusNet's profitability) into the future.

The AER asserts that this lower level of spending is somehow efficient, but its criteria are neither defined nor justified. Obviously the appropriate amount to spend on maintenance is a matter of operational judgement and sound management. There is no mechanism in the current system to provide an independent, bottom-up assessment of the need for maintenance or other operating expenses.

CitiPower[18]: A**s** with AusNet, CitiPower's operating expenditure has fallen below AER approved forecasts by $15 to $25 million per year, from 2016 through to the present. The AER justifies this pattern with similar argumentation:

> "We use an incentive approach where, once regulated revenues are set for a five year period, networks who keep actual costs below the regulatory forecast of costs retain part of the benefit. This incentive framework is a foundation of the regulatory framework, which aims to promote the NEO. Service providers have an incentive to become more efficient over time, as they retain part of the financial benefit from improved efficiency. Consumers also benefit when efficient costs are revealed and a lower cost benchmark is set in subsequent regulatory periods." (p. 21)

Jemena[19]: This pattern of phony overachievement is repeated for Jemena. Like the other companies, its annual operating costs have consistently fallen below the AER forecasts since 2016 (by around $10-15 million per year).

However, in this case the regulatory process revealed the pro-active role of the AER in suppressing targeted operating expenses, below which the company would seek to over-achieve. For the next five-year period (running to 2026), the AER complained that it was "not satisfied that Jemena's opex forecast is prudent and efficient" (p. 36). Jemema had requested a significant increase in allowable operating expenditure,

[18] AER (2020) Draft determination: CitiPower Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20CitiPower%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020_0.pdf

[19] AER (2020) Draft determination: Jemena Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20Jemena%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020.pdf

presumably necessitated by operational requirements.[20] Instead the AER capped operating expenses at about the same level as its previous approved forecast (around $100 million per year), and then required an annual reduction in that ceiling over the period to 2026.

Powercor[21]: Like the other companies surveyed above, Powercor demonstrated a consistent ability to undercut approved operating expenses, by an average of around $40 million per year from 2016 through 2020.

Powercor then proposed an increase in annual operating expenses, to an average of around $300 million per year over the subsequent five-year period (a continuation of the trend in the previously-approved forecasts, but a significant increase over actual expenditures). In its draft determination, the AER cut back the request by a five-year total of $180 million, or 12 per cent. But that was still slightly higher than the opex forecast approved in the AER's previous five-year decision – and much higher than realized operating expenses over that period (given Powercor's predictable overachievement of those benchmarks).

United Energy[22]: A similar pattern is visible in the case of United Energy. Since 2016, its operating expenditures have fallen well under the ceiling approved by the regulator, and have been falling. Actual costs were $40 million below approved levels (25% under) in both 2018 and 2019, delivering a significant boost to United Energy's bottom line. The AER's determination was well below the company's proposal over the coming five-year period – but well above its actual expenses in recent years. So the stage has been set again for another round of phony overachievement.

* * * * *

Based on the data reviewed for the companies considered above, we can assemble an aggregate estimate of total operating expenditure for these Victorian distributors, summarized in Table 3.

[20] Jemema's expected operating expenses for the half-year period in 2021 were significantly higher than in the preceding period.

[21] AER (2020) Draft determination: Powercor Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20Powercor%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020.pdf

[22] AER (2020) Draft determination: United Energy Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20United%20Energy%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020_0.pdf

Table 3 Operating Expenses, 5 Victorian Distributors	
	Total operating expenditure ($m)
2016	2,813
2017	2,793
2018	2,738
2019	2,748
2020	2,770
Source: AER (2020) Draft company distribution determinations 2021 to 2026.	

Table 3 indicates that aggregate operating expenses across the five companies have been stagnant in nominal terms (at $2.7-$2.8 billion per year), which implies a downward trend in real terms (after inflation). This will lead to a reduction in the real maintenance effort, given nominal unit costs (for labour, materials, and other inputs) will have increased over this period. However, the AER draft revenue determinations for Victorian electricity distributers indicate consistent gaps between regulated maxima for operating expenditures and the actual amounts spent. This is not surprising, since the incentive structure in the industry is to maximise approved expenses (thus increasing regulated maximum revenue) while subsequently minimizing actual spending. This provides a two-sided boost to the bottom-line profit of the distributors.

Table 4 Underspending on Operating Expenditure, 5 Victorian Distributors ($m)						
	CitiPower	**AusNet**	**Jemena**	**Powercor**	**United Energy**	**Total**
2016	10	0	10	40	2	62
2017	12	20	3	25	15	75
2018	22	40	15	30	42	149
2019	15	48	10	40	41	154
2020	15	50	12	28	39	144
Total	74	158	50	163	139	584
Sources: Authors' estimates from AER (2020) Draft company Distribution Determinations 2021 to 2026.						

Table 4 provides estimates (based on graphical illustrations included in the AER draft determinations) of the annual difference between the AER regulated operating expense forecasts and the actual spending by each distributor. A positive number in Table 4 indicates that the company underspent its regulated amount in that year.

Table 4 confirms that in every year, every company underspent its approved operating expenses. The only exception was AusNet in 2016 – when operating expenses matched the approved forecast. Overall, the collective underspend totalled over one-half billion dollars over this 5-year period. Underspends in the last three years were equal to 5 per cent of the AER ceilings, which themselves have been increasingly tight.

This incentive structure clearly encourages over-bidding on the part of the regulated entity in order to get a good revenue result. Then, in practice, the company skimps on spending and standards so as to increase profits while still staying within the regulator's revenue ceiling.

In most cases the regulator has described how these companies also underspent on their capital expenditure forecasts. For example, the AER said United Energy underspent its current period capex allowance by 20 per cent.[23] For both investment and maintenance, therefore, the current regulatory system is fostering a consistent pattern of underspending and underinvestment – at a time when the electricity system faces unprecedented technological, economic, and environmental stresses.

NSW Determinations

In 2019 and 2020, the AER also completed a new round of final determinations regarding distribution companies in NSW. While revealing nuances in approach, the NSW experience reveals the same pattern of double-sided suppression of maintenance expenses: with approved ceilings restrained by the regulator purportedly to save consumers money, and then those ceilings purposely undercut by companies seeking an extra profit margin.

Essential Energy[24]: In the case of Essential Energy, the AER believed (without obvious supporting evidence) that distribution services could be provided "at substantially

[23] AER (2020) Draft determination: United Energy Distribution Determination 2021 to 2026 https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20-%20United%20Energy%20distribution%20determination%202021-26%20-%20Overview%20-%20September%202020_0.pdf

[24] AER (2019) Draft determination: Essential Energy Distribution Determination 2019 to 2024 https://www.aer.gov.au/system/files/AER%20-%20Final%20decision%20-%20Essential%20Energy%20distribution%20determination%202019-24%20-%20Overview%20-%20April%202019.pdf

lower cost than suggested by historical expenditure, while still maintaining safety and complying with reliability obligations" (p.13). The regulator imposed an arbitrary annual assumed productivity improvement in order to reduce allowable maintenance expenditures each year – denying the strong evidence that underlying productivity in the industry as a whole has been falling, not rising. The AER wishfully asserts that "this productivity growth comes from such things as the adoption of new technology, changes to management practices and other factors that contribute to improved productivity within the industry over time." (p. 32)

From 2014-15 Essential's operating expenditure spending fell been below the permitted AER forecasts by a cumulative total of approximately $50 million. However, the new determination imposes an operating cost ceiling of around $300 million in 2023-24, well down on the $375 million in 2018-19.[25] In this case, the company's (predictable) overachievement of operating cost thresholds in previous years brought about a significant tightening of those thresholds into the future.

Endeavour[26]: Endeavour's operating expenditure started the last 5-year regulatory cycle well above the regulated ceiling, but was then substantially reduced and ended the period below the regulated amount. In 2013-14 the regulated cap on operating expenditure was about $385 million, and that was cut to around $275 million in 2018-19. That much lower figure was then used as the starting point for operating cost forecasts in the 2019-24 regulatory period, cutting back the company's proposal by a cumulative $32 million over five years.

With Endeavour, too, the AER invoked target productivity growth as the driver for these enforced reductions in operating costs:

> "The reason we have not accepted Endeavour's revised opex proposal is our decision to include a productivity growth forecast of 0.5 per cent per year in our estimate of efficient forecast opex. Productivity growth captures the improvements in good industry practice that should be implemented by efficient distributors as part of business-as-usual operations. This comes from such things as new technology, changes to management practices and other factors that contribute to improved productivity within the industry over time. Endeavour did not included

[25] Estimated from AER figures.

[26] AER (2019) Final decision: Endeavour Energy Distribution Determination 2019 to 2024 https://www.aer.gov.au/system/files/AER%20-%20Final%20decision%20-%20Endeavour%20Energy%20distribution%20determination%202019-24%20-%20Overview%20-%20April%202019.pdf

[sic] any forecast opex productivity growth in its revised proposal." (p. 31)

Ausgrid[27]: In the case of Ausgrid, previous regulatory decisions led to a dramatic reduction in operating costs over the previous five-year regulatory determination. Ausgrid's total operating expenses plunged from over $700 million in 2014-15 to just $450 million by 2018-19 – a reduction of over one-third. This sharp decline in Ausgrid actual spending caught up with an equally dramatic reduction, first imposed in 2014, in the approved AER operating cost forecast. In this case there were no profit dividends to the company for overachieving the forecast – not surprising given the aggressive cost reductions imposed by the regulator. Ausgrid's response to the reduction in approved costs included a 34 per cent reduction in staffing. Concerns have also been expressed regarding the impact of these spending cuts on Ausgrid's capacity to undertake adequate bushfire prevention activities across its network.[28]

For the next five-year regulatory cycle, the AER determination for Ausgrid also adjusted approved forecast operating expenditure for assumptions regarding productivity growth. For the period 2019-24, the AER imposed a one per cent annual productivity saving, above and beyond the dramatic reductions in operating expenses incurred after 2014-15.

* * * * *

In NSW, the AER imposed more severe caps on operating expenditure. That left less scope for companies to come in under those caps, and thus reap extra profits – but there was some evidence of that practice. In addition, the AER has been more aggressive in reducing approved operating expense caps, including through the imposition of assumed productivity dividends and even more dramatic step changes in allowed costs. This aggressive approach has led to major staff retrenchments and operating cost reductions.

COMPANY LEVEL DATA: TRANSMITTERS

In this section, we briefly consider AER company-level determinations and data regarding the major transmitters in each state.

[27] AER (2019) Final decision: Ausgrid Distribution Determination 2019 to 2024 https://www.aer.gov.au/system/files/AER%20-%20Final%20decision%20-%20Ausgrid%20distribution%20determination%202019-24%20-%20Overview%20-%20April%202019.pdf

[28] See, for example, McKell Institute and ETU NSW (2019).

Powerlink (Qld)[29]: The current AER Powerlink 'framework and approach' position paper notes that Powerlink uses an efficiency benefit sharing scheme which "aims to provide a continuous incentive for TNSPs [Transmitters] to pursue efficiency improvements in opex [operating expenditure], and provide for a fair sharing of these efficiencies between TNSPs and network users."

Operating expenditure reached a peak in 2014-15 at around $220 million, but is now subject to declining spending: falling from approximately $197 million at the beginning of the new regulatory period in 2017-18, and set to decline slightly further by 2021-22. The AER had actually proposed a higher amount, but Powerlink's own proposal came in below the regulator's proposal.

TransGrid (NSW)[30]: In this case, the AER's draft decision was to reduce TransGrid's operating expenditure by a cumulative $75 million over the period 2018-23. Operating expenditure at TransGrid had already been cut from a peak of around $190 million in 2013-14, reaching approximately $170 million in 2017-18. That fell slightly under the regulated amount, providing a small surplus profit for the company.

AusNet Services (Vic)[31]: AusNet's spending on operating expenditure in its transmission system peaked in 2009-10 at approximately $200 million and was set to increase to around $226 million over the period 2017-18 to 2021-22. However, this increase was to allow for an increase in the easement tax levied by the Victorian Government. This suggests that from 2009-10 to 2021-22 there is to be no real increase in operating expenditure.

ElectraNet (SA)[32]: ElectraNet has enjoyed increases in operating expenditure from about $68 million in 2008-09 to around $94 million in 2017-18. However, the ASER determination for the period to 2022-23 keeps spending below the 2017-18 level. Given large changes in the SA grid over the last decade, the increases to 2017-18 were

[29] AER (2020) *Framework and Approach Powerlink Regulatory control period commencing 1 July 2022* https://www.aer.gov.au/system/files/AER%20-%20Powerlink%202022-27%20-%20Framework%20%26%20Approach%20-%20July%202020.pdf

[30] AER (2017) Draft decision: TransGrid transmission determination 2018 to 2023, https://www.aer.gov.au/system/files/AER%20-%20Draft%20decision%20TransGrid%20transmission%20determination%20-%20Overview%20-%2028%20September%202017.pdf

[31] AER (2017) *AusNet Services transmission determination, 2017-2022* https://www.aer.gov.au/system/files/AER%20-%20AusNet%20Services%202017-22%20-%20Final%20decision%20overview%20-%20April%202017.pdf

[32] AER (2018) Final determination: ElectraNet transmission determination 2018 to 2023https://www.aer.gov.au/system/files/D18-43867%20ElectraNet%20final%20decision%20overview.pdf

warranted, and it is worth noting that expenditures still came in under the AER cap (except for 2011-12).

TasNetworks (Tas)[33]: The data for TasNetworks show a dramatic fall in transmission operating expense from about $59 million in 2009-10 down to just $28 million in 2018-19: representing a decline of more than half. The AER's approved ceilng will be held at roughly that amount for the years to 2023-24.

* * * * *

The company-specific data reviewed above, covering both distribution and transmission, thus confirm the earlier conclusion that operating expenditure and maintenance have been on a downward trend for most of the last decade. As discussed above, real operating expenses in the overall distribution network have fallen 14 per cent since 2006-07. The decline in the transmission sector was steeper: 21 per cent in real terms. Adjusted for the growth in the customer base, real per customer operating costs in distribution fell 28 per cent in distribution, and 33 per cent in transmission. Had expenditure on operating costs and maintenance kept pace with the customer base and rising price levels in this period, that expenditure would be more than $1 billion per year higher than it currently is.

As is well known, the demand for electricity has been stagnant in recent years, as customers adjust to higher prices and new technologies reduce energy demand. However, the demands on the transmission and distribution system do not shrink, just because average energy consumerd per customer has declined. To the contrary, the requirements for a high-quality transmission and distribution infrastructure will grow with Australia's growing population, as well as factors such as increased environmental stresses (from severe weather, climate change, and more) and the changing geography of electricity generation (resulting from new renewable technologies). AER data show that since 2012 the number of network customers has increased by over 10 per cent, while the maximum demand on the system has also increased by 10 per cent, and the geographical dispersion of generation has increased. All that would suggest the need for increasing operating expenditure. In addition, the decline in new capital spending in the transmission and distribution sectors would also suggest a growing need for maintenance expenditures, in order to sustain an ageing capital stock in good working order. Instead, the existing regulatory and competitive structure has facilitated a continuing contraction in maintenance spending: the regulator drives down allowed

[33] AER (2019) Final decision: TasNetworks Transmission and Distribution Determination 2019 to 2024 https://www.aer.gov.au/system/files/AER%20-%20TasNetworks%202019-24%20-%20%20Transmission%20and%20Distribution%20determination%20-%20Final%20decision%20-%20Overview%20-%20April%202019.pdf

spending levels in its continuing charade of ‘protecting the consumer’, and the private companies then drive budgets down further in order to capture extra profits within the envelope of their allowed revenues. None of this has benefited customers (who pay much higher real prices), but it certainly threatens the integrity and reliability of the system.

Conclusions and Policy Recommendations

This report has reviewed three broad sets of evidence regarding the persistent pattern of underinvestment in the reliability and safety of Australia's electricity transmission and distribution system:

- First-hand accounts provided by dozens of front-line workers in the industry, from several states and a variety of occupations, attesting to their personal and professional experience with inadequate maintenance and its consequences.
- The findings of other published research and public reviews, which have documented the growing problems of ageing infrastructure, lack of asset redundancy and back-up capacity, and inadequate preventative maintenance – and how these problems have contributed to system failure, accidents, and disasters (such as bushfires).
- A review of aggregate statistical evidence confirming the decline in maintenance and upgrading expenditures, and the reallocation of resources within electricity firms away from the 'real' work of operating and maintaining the grid in favour of various overhead, marketing, and finance functions that are driven more by profit-seeking opportunities than by the primary objective of delivering reliable, affordable electric power. This section also documented how this misallocation has produced the incongruous combination of declining employment in operation and maintenance, soaring consumer prices, and swollen industry profits.

This evidence confirms that the current regulatory system, combined with the profit motive of private system providers, is producing systematic underinvestment in network capacity, safety and reliability. The supposed focus of the regulatory system on ensuring reliable, affordable electricity supply and preventing abuse by private transmission and distribution companies of their proferred monopoly positions, has clearly not succeeded. Profits are enormous; consumer prices have increased dramatically; real resources dedicated to modernising and maintaining the system have diminished; and measures of efficiency and productivity have deteriorated. This industry is being mismanaged – by both its private owners and managers, and by regulators – in a manner which produces waste, rent-seeking, and exploitation of both workers and consumers.

The challenges facing the national grid are becoming more intense. The ageing infrastructure, undermined by a sharp decrease in capital spending over the past decade, will require more upkeep, preventative maintenance, and back-up capabilities to avoid an escalation of system failures and breakdowns. Climate change and more frequent severe weather events place the system under increased stress, raising the risk of catastrophic events – including bushfires caused by the electrical grid. The accelerating shift to renewable energy sources, necessary as part of Australia's response to climate change, poses unique challenges to the transmission and distribution systems, in light of the dispersed geographical location of renewable generation assets, their variability in supply, and the necessity of multi-directional electricity flows.

For all these reasons, a prudent management and regulatory system should be urgently allocating more attention and investment to grid maintenance and upgrading, not less. However, in the false hope of suppressing costs and reducing prices, recent AER determinations confirm its continuing and misguided focus on rolling back maintenance budgets, without appropriate attention to the practical realities of operating a transmission and distribution network in the face of growing economic, technological, and environmental stresses. The AER's approach has unleashed a predictable and artificial cycle whereby regulated energy businesses submit proposals for maintenance spending that are routinely pushed back by the regulator – only to then be underspent by the private operators seeking to further pad their profit margins. Meanwhile consumer prices increase still further, and the capability of the system to address emerging challenges is thrown further into question.

It is time to fundamentally rethink a system that claims to be harnessing the power of market-driven efficiency in the interests of consumer well-being, but in fact is facilitating pointless and inefficient self-dealing, financialisation, and short-sightedness. The irrational and unintended effects of the current privatised, fragmented, and poorly regulated system suggest that the entire shift to private ownership of a system which possesses many features of a natural monopoly should be reconsidered. Our previous research (see Richardson, 2019) has described and critiqued the broader failure of privatisation in this light. For current purposes, however, we will confine our recommendations to making proposals for incremental changes to address some of the most damaging and self-defeating aspects of the current regulatory and competitive regime.

To address chronic underinvestment in the grid's capital stock, capability, and reliability that has become increasingly evident over the past decade, we make the following recommendations:

I. AER determinations of allowable capital, upgrading and maintenance investments by regulated energy businesses should be ascertained on the basis of concrete bottom-up auditing of system capability, reliability and performance, undertaken by independent arms-length technical experts. The present system, in which energy businesses submit 'proposals' (reflecting a mixture of genuine operational priorities and self-interested financial positioning) which are then routinely and arbitrarily rolled back by the AER (on the basis of unexplained statistical judgments) does not systematically consider front-line evidence regarding the shifting needs and challenges facing the actual network. Regulation of capital and maintenance expenditures thus needs to be 'grounded' in analysis of real-world challenges and constraints facing the system – including assessments of additional requirements arising from climate change and severe weather, risk mitigation (including bushfire prevention and vegetation management), and challenges related to the roll-out of renewable generation capacity. A broader economic benefit test should be applied to ensure the interests of workers and the community are factored into decision-making around capital investments and upkeep.

II. Once appropriate levels of system capital and maintenance expenditures have been identified, explicit mechanisms must be established to reflect and recover those costs in regulated electricity prices.

III. When adverse events (such as severe weather, bushfires, or other occurrences) necessitate capital or repair expenditures above and beyond previously approved regulated levels, provisions for additional cost recovery must also be accessible.

IV. Costing of capital installation, upgrading, and maintenance expenditure must take explicit account of the need for high-quality skilled, certified labour to perform that work. Those labour requirements must be reflected in corresponding provisions for payment appropriate wages, entitlements and working conditions in line with industry best practices.

V. The accelerating transition to renewable energy sources, through both utility-scale projects and distributed sources, poses a unique and historic challenge to the capabilities of the national transmission and distribution grid. The AER, in conjunction with the AEMO and other industry bodies, should undertake a thorough assessment of the investments and system changes that will be required to meet the new requirements of an increasingly renewables-focused power system. This assessment must incorporate a broader economic and social cost-benefit lens, rather than the current narrowly-defined conception of economic costs. The findings of this assessment must then inform the AER's subsequent determinations regarding allowable capital and maintenance expenditures by regulated businesses.

VI. Businesses which underspend allowed capital and maintenance budgets should be issued financial penalties which offset the impact of this underspending on their operating margins. This would eliminate the current perverse incentive for private transmitters and distributors to artificially suppress needed maintenance and upgrades in the interests of a short-term bonus over and above their already-substantial profit margins.

VII. The AER must undertake more detailed reviews of the submitted overheaed, marketing, and financial activities of regulated energy businesses. Our evidence indicates a substantial reallocation of real resources within the industry toward these unproductive activities, which are motivated by rent-seeking, not providing affordable, reliable electricity. Instead of providing blanket approval for whatever operating expenses companies deem to be in their interests, within an overall ceiling that is not differentiated with respect to specific activity, the regulator should focus on reducing the deadweight costs of duplicated, self-serving corporate bureaucracies – which have contributed so notably to the irrational and harmful outcome of the current regime.

Australia's private electricity providers have profited immensely from a regulatory regime which has been 'rigged' to allow steady growth in profits from a system that shows a marked deterioration in real performance. The volume of output in the industry has been stagnant for almost a decade. Resources dedicated to the real tasks of modernisation, upgrading and maintenance have been curtailed – as has employment for the actual electrical specialists who perform that work. Massive resources have been redirected, instead, to ultimately unproductive corporate and financial activities. Meanwhile, consumers pay unprecedented prices for service with sub-optimal reliability. The current competitive and regulatory structure of the industry is serving neither consumers, nor electrical workers, nor the environment. Our proposals would constitute a first but important step in remedying this failure.

Appendix A

Table A1 Workers by Detailed Occupation in Electricity Transmission and Distribution, 2016 Census			
OCCP - 4 Digit Level	**Electricity Transmission**	**Electricity Distribution**	**Total**
Managers, nfd	8	124	132
Chief Executives and Managing Directors	13	31	44
General Managers	16	124	140
Specialist Managers, nfd	11	136	147
Advertising, Public Relations & Sales Mgrs	30	206	236
Business Administration Managers, nfd	6	25	31
Corporate Services Managers	4	15	19
Finance Managers	18	142	160
Human Resource Managers	37	281	318
Policy and Planning Managers	12	106	118
Research and Development Managers	0	18	18
Construction, Dist'n & Prod'n Mgrs, nfd	8	53	61
Construction Managers	59	305	364
Engineering Managers	30	200	230
Importers, Exporters and Wholesalers	9	16	25
Production Managers	8	41	49
Supply, Distribution & Procurement Mgrs	17	205	222
Health and Welfare Services Managers	0	3	3
ICT Managers	40	292	332
Other Specialist Managers	34	401	435
Retail Managers	3	25	28
Call/Contact Centre & Customer Serv. Mgrs	9	133	142
Conference and Event Organisers	0	19	19
Transport Services Managers	4	38	42
Other Hospitality, Retail & Service Mgrs	18	140	158
Professionals, nfd	29	292	321
Authors, and Book and Script Editors	0	7	7
Journalists and Other Writers	0	20	20
Business, HR & Marketing Professionals, nfd	4	22	26

Accountants	57	411	468
Auditors, Co. Sect's & Corporate Treasurers	17	184	201
Financial Brokers	0	21	21
Financial Dealers	0	39	39
Financial Investment Advisers & Mgrs	8	49	57
Human Resource & Training Prof's, nfd	0	3	3
Human Resource Professionals	25	229	254
Training and Development Professionals	13	126	139
Information & Organisation Prof's, nfd	0	6	6
Actuaries, Mathematicians and Statisticians	0	10	10
Archivists, Curators and Records Managers	4	19	23
Economists	5	35	40
Intelligence and Policy Analysts	7	32	39
Land Economists and Valuers	14	16	30
Management and Organisation Analysts	38	455	493
Other Information & Organisation Prof's	17	170	187
Sales, Marketing & PR Professionals, nfd	0	3	3
Advertising and Marketing Professionals	6	106	112
Public Relations Professionals	16	57	73
Technical Sales Representatives	28	65	93
Design Eng'g, Science & Transport Prof's nfd	5	5	10
Architects, Designers, Plnrs & Surveyors, nfd	0	43	43
Architects and Landscape Architects	0	4	4
Surveyors and Spatial Scientists	13	119	132
Graphic and Web Designers, and Illustrators	0	19	19
Interior Designers	0	3	3
Urban and Regional Planners	4	12	16
Engineering Professionals, nfd	27	106	133
Chemical and Materials Engineers	0	3	3
Civil Engineering Professionals	31	58	89
Electrical Engineers	405	1523	1928
Electronics Engineers	9	12	21
Industrial, Mechanical & Production Eng'rs	25	98	123
Mining Engineers	0	16	16
Other Engineering Professionals	0	15	15
Chemists, and Food and Wine Scientists	0	3	3
Environmental Scientists	18	86	104
Other Natural & Physical Science Prof's	0	8	8

Vocational Education Teachers	3	86	89
Education Advisers and Reviewers	0	7	7
Occupational & Environmental Health Prof's	17	128	145
Occupational Therapists	0	4	4
ICT Professionals, nfd	14	99	113
Bus./Systems Analysts & Programmers, nfd	0	3	3
ICT Business and Systems Analysts	27	235	262
Multimedia Specialists and Web Developers	3	3	6
Software and Applications Programmers	26	209	235
Database/Systems Admin. & ICT Security	30	177	207
Computer Network Professionals	23	96	119
ICT Support and Test Engineers	6	46	52
Telecommunications Engineering Prof's	30	67	97
Judicial and Other Legal Professionals	0	21	21
Solicitors	9	49	58
Counsellors	0	4	4
Psychologists	0	3	3
Social Professionals	0	3	3
Welfare, Recreation & Comm'ty Arts Wrkrs	0	4	4
Technicians and Trades Workers, nfd	10	94	104
Engineering, ICT & Science Technicians, nfd	8	16	24
Agricultural Technicians	0	3	3
Science Technicians	0	10	10
Building and Engineering Technicians, nfd	7	36	43
Architectural, Building & Surveying Tech'ns	27	266	293
Civil Engineering Draftspersons & Tech'ns	9	23	32
Electrical Eng'g Draftspersons & Techn'ns	95	1137	1232
Electronic Eng'd Draftspersons & Tech'ns	4	13	17
Mechanical Eng'g Draftspersons & Tech'ns	0	14	14
Safety Inspectors	3	34	37
Other Building and Engineering Technicians	17	169	186
ICT & Telecommunications Technicians, nfd	0	3	3
ICT Support Technicians	28	147	175
Telecommunications Technical Specialists	18	31	49
Automotive & Eng'g Trades Wrkrs, nfd	0	13	13
Motor Mechanics	4	47	51
Sheetmetal Trades Workers	0	8	8
Structural Steel & Welding Trades Workers	0	27	27

Metal Fitters and Machinists	14	136	150
Precision Metal Trades Workers	4	82	86
Carpenters and Joiners	0	3	3
Plumbers	0	133	133
Electrotechnology & Telecom. Trades, nfd	10	191	201
Electricians	238	2919	3157
Electronics & Telecom. Trades, nfd	0	29	29
Airconditioning & Refrigeration Mechanics	0	9	9
Electrical Distribution Trades Workers	145	3940	4085
Electronics Trades Workers	0	24	24
Telecommunications Trades Workers	23	117	140
Gardeners	6	60	66
Miscellaneous Technicians & Trades, nfd	0	4	4
Chemical, Gas, Power Plant Operators	31	283	314
Other Miscellaneous Technicians & Trades	29	265	294
Welfare Support Workers	0	6	6
Fire and Emergency Workers	0	36	36
Security Officers and Guards	0	20	20
Other Personal Service Workers	0	3	3
Clerical and Administrative Workers, nfd	0	17	17
Office Managers & Program Admin., nfd	0	18	18
Contract, Program & Project Administrators	145	1182	1327
Office Managers	20	166	186
Practice Managers	0	4	4
Personal Assistants	24	167	191
Secretaries	10	26	36
General Clerical Workers, nfd	0	4	4
General Clerks	28	641	669
Keyboard Operators	13	351	364
Inquiry Clerks and Receptionists, nfd	0	7	7
Call/Contact Centre Information Clerks, nfd	0	3	3
Call or Contact Centre Workers	5	503	508
Information Officers	23	650	673
Receptionists	14	39	53
Numerical Clerks, nfd	0	5	5
Accounting Clerks	35	419	454
Bookkeepers	0	16	16
Payroll Clerks	11	85	96

Financial and Insurance Clerks, nfd	0	6	6
Credit and Loans Officers	0	23	23
Insurance, Money Mkt. & Statistical Clerks	5	20	25
Clerical and Office Support Workers, nfd	0	5	5
Filing and Registry Clerks	5	36	41
Mail Sorters	0	5	5
Switchboard Operators	0	15	15
Other Clerical and Office Support Workers	11	123	134
Logistics Clerks, nfd	0	9	9
Purchasing and Supply Logistics Clerks	37	274	311
Transport and Despatch Clerks	4	70	74
Conveyancers and Legal Executives	3	13	16
Debt Collectors	0	39	39
Human Resource Clerks	7	147	154
Inspectors and Regulatory Officers	7	199	206
Library Assistants	0	5	5
Other Misc. Clerical and Admin. Workers	16	59	75
Sales Workers, nfd	0	7	7
Sales Representatives	15	157	172
Real Estate Sales Agents	3	14	17
Sales Assistants and Salespersons, nfd	0	13	13
Sales Assistants (General)	5	149	154
ICT Sales Assistants	0	6	6
Retail Supervisors	0	9	9
Service Station Attendants	0	4	4
Street Vendors and Related Salespersons	0	24	24
Telemarketers	0	73	73
Machinery Operators and Drivers, nfd	3	36	39
Machine & Stationary Plant Operators, nfd	0	5	5
Machine Operators, nfd	5	16	21
Textile & Footwear Prod'n Machine Opertrs.	0	3	3
Other Machine Operators	0	3	3
Stationary Plant Operators, nfd	0	4	4
Crane, Hoist and Lift Operators	4	91	95
Drillers, Miners and Shot Firers	0	5	5
Other Stationary Plant Operators	0	12	12
Earthmoving Plant Operators	0	9	9
Forklift Drivers	4	39	43

Other Mobile Plant Operators	0	4	4
Road and Rail Drivers, nfd	0	6	6
Delivery Drivers	0	8	8
Truck Drivers	0	59	59
Storepersons	18	145	163
Labourers, nfd	0	15	15
Cleaners and Laundry Workers, nfd	0	5	5
Commercial Cleaners	0	22	22
Other Cleaners	0	5	5
Construction and Mining Labourers, nfd	0	5	5
Building and Plumbing Labourers	0	20	20
Structural Steel Construction Workers	0	17	17
Other Construction and Mining Labourers	0	9	9
Factory Process Workers, nfd	0	7	7
Packers	0	4	4
Product Assemblers	5	0	5
Product Quality Controllers	0	16	16
Forestry and Logging Workers	0	7	7
Garden and Nursery Labourers	6	18	24
Other Farm, Forestry and Garden Workers	0	5	5
Kitchenhands	0	3	3
Other Miscellaneous Labourers	5	151	156
Inadequately described	33	324	357
Not stated	0	20	20
Source: Authors' calculations from ABS Census, 2016.			

References

Asset Reliability Improvement Association (2018). *Submission by ARIA on Practical Reliability Engineering Opportunities for the National Electricity System*, coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Asset%20Reliability%20Improvement%20Association%20%28ARIA%29%20response%20to%20Energy%20Guarantee%20consultation.pdf.

Australian Energy Regulator (2020). *State of the Energy Market 2020* (Melbourne: Commonwealth of Australia).

Commonwealth of Australia (2020). *Royal Commission into National Natural Disaster Arrangements Report*, 28 October, https://naturaldisaster.royalcommission.gov.au/.

Government of South Australia (2020). *Investigation Report: Yorke Peninsula fire 20 November 2019*, https://energymining.sa.gov.au/__data/assets/pdf_file/0004/369436/D20021892_20200616_Yorke_Peninsula_fire_report_printed_20200819.pdf.

Independent Panel for Electricity Distribution and Service Delivery for the 21st Century (2004). *Detailed Report of the Independent Panel 'Sommerville Review'*, https://www.parliament.qld.gov.au/documents/tableOffice/TabledPapers/2004/5104T1106.pdf.

McKell Institute and ETU NSW (2019). *Submission to the AER: Draft Determination on AusGrid, Regulatory Period 2019-2024*, February, https://static1.squarespace.com/static/583e06f72e69cf1be587a417/t/5c60bc3f24a6947f23f82ccd/1549843529586/McKell+Institute+and+ETU+NSW+-+Ausgrid+Determination+2019-2024.pdf.

Miller, Clare, Matt Plucinski, Andrew Sullivan, Alec Stephenson, Carolyn Huston, Kay Charman, and Mahesh Prakash (2017). "Electrically caused wildfires in Victoria, Australia are over-represented when fire danger is elevated," *Landscape and Urban Planning*, 167, pp. 267-274.

NSW Government (2020) *Final Report of the NSW Bushfire Inquiry*, https://www.dpc.nsw.gov.au/assets/dpc-nsw-gov-au/publications/NSW-Bushfire-Inquiry-1630/Final-Report-of-the-NSW-Bushfire-Inquiry.pdf.

Richardson, David (2019). *The Costs of Market Experiments: Electricity Consumers Pay the Price for Competition, Privatisation, Corporatisation and Marketization* (Canberra: ustralia Institute).

Teague, Bernard, Ronal McLeod, and Susan Pascoe (2010). *2009 Victorian Bushfires Royal Commission Final Report*, July, http://royalcommission.vic.gov.au/FinalDocuments/Summary/PF/VBRC_Summary_PF-3.pdf.