Submission to EPA Victoria on the brown-coal power stations licence reviews

8 February 2018

SUMMARY OF RECOMMENDATIONS

1. The EPA must amend licences to dramatically reduce the toxic pollution from the power stations.

1.1 The EPA must amend all three licences to achieve international best practice emissions limits for the power stations with the aim of reducing emissions to as low as possible to protect human health.

2. EPA must consider climate change and regulate greenhouse gas emissions

2.1 The EPA should regulate greenhouse gas emissions from the power stations in accordance with its powers under the EP Act.

3. EPA must rapidly move to a Load Based Licencing scheme

3.1 The Victorian Government should move toward adopting a Load-Based Licencing scheme by removing legislative barriers, consistent with the recommendations of the 2015 Independent Inquiry into the EPA.

3.2 In developing a Load Based Licencing Scheme, the EPA should ensure that the fees are set at a level that effectively incentivises emission reduction and internalises the cost of the pollution.

4. EPA must improve licence conditions regarding the monitoring and reporting of emissions

4.1 The EPA should amend licences for all three power stations to require continuous automatic emissions monitoring from all stacks for NOx, SO_2, PM_{10}, $PM_{2.5}$ and mercury with a requirement that the data be released publicly in real time. Full datasets should be verified by the power station operators and available within 14 days to any person on request. Power station operators should be required to test their stacks annually and to ensure that the continuous monitors are functioning properly.

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4.1 The EPA should obtain all monitoring data from the ambient air monitoring stations in the LVAMN and have it available on its website as downloadable datasets within 14 days of the data being recorded.

5. EPA must improve the management and compliance of dust emissions from mines

5.1 The EPA should take responsibility for the management of mine dust emissions by including much more prescriptive licence conditions to prevent dust emissions in the power station licences.

5.2 The EPA should take responsibility for compliance of dust emission requirements by actively enforcing them. This should not be left to DEDJTR, an agency that is unlikely to take such enforcement action.

6. Groundwater Contamination Management and Monitoring from Coal Ash dumps

6.1 EPA should include specific licence conditions for groundwater contamination monitoring at the ash pond landfill sites.

6.2 EPA should impose specific licence conditions that sources of groundwater contamination are adequately managed and, where practicable, cleaned up. In particular, management of the Loy Yang Groundwater Attenuation Zone needs to be more stringent than just monitoring the migration of the contamination plume.

6.3 All groundwater monitoring information should be made publicly available as downloadable datasets. Groundwater contamination information, including reports on plume management and migration at Loy Yang and hydrogeological assessments, should be publicly available.

7. Closure and rehabilitation bonds

7.1 The Victorian Government must establish standards and guidelines for decommissioning and rehabilitation of coal ash dams, and hold bonds from generators to ensure these best practices are implemented.

8. Concerns about this review process

8.1 The EPA should engage an independent evaluation of the community engagement practices and protocols reflected in this licence review, with recommendations to strengthen engagement practices in the future. The review should be circulated for discussion by the EPA Board.

SUMMARY OF HEALTH IMPACTS FROM POWER STATION EMISSIONS

Despite improvements in some places during the past two decades, a 2013 Senate Committee inquiry found that air pollution is still a major problem in many parts of Australia.[1] More than 3,000 people die from air pollution in Australia every year[2] – almost three times the national road toll. All State, Territory and Commonwealth governments have acknowledged that there is no 'safe' level of exposure for many pollutants and there are harmful impacts from exposure at levels even below the current air pollution standards.[3] In the past two years alone, numerous research studies have been released showing the significant health impacts of air pollution, even at low levels. For example:

- A 2017 study from the USA revealed a substantial effect on infant birth weight for mothers living downwind (up to 70kms away) of a coal fired power station releasing 30,000 tonnes of SO_2 per year (power stations in the Latrobe Valley release about 100,000 tonnes SO_2 per year).[4] Birthweights improved after the power station closed.

- Recent Australian research shows that NO_2 pollution has an impact on allergies, asthma and lung function even at low levels of air pollution.[5]

- A 2017 study from the USA which was the largest ever study of its kind (involving 61 million people) showed an increasing risk of death with increasing level of $PM_{2.5}$ and ozone, even at levels below EPA standards; and a greater risk of death greater among minority groups or low socio-economic status.[6]

- A 2017 study from China, co-authored with Monash University in Melbourne, found that a PM_1 concentration increase of just 10 µg/m3 was associated with a 9% increased risk of premature birth.[7] PM1 is produced during coal combustion and is not monitored or regulated in Australia. This study further reinforces the need to reduce all particle pollution to as low as possible.

According to the National Pollutant Inventory, coal-fired power stations are the largest source of sulphur dioxide (SO_2), oxides of nitrogen (NOx), and fine particle pollution ($PM_{2.5}$), all of

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[1] Senate Community Affairs References Committee (2013) 'Impacts on Health of Air Quality in Australia, Parliament of Australia, p3.
[2] Begg, S et al. (2007) 'The burden of disease and injury in Australia 2003', Australian Institute of Health and Welfare, Cat. no. PHE 82, Canberra, 2007, p. 96
[3] Doctors for the Environment Australia (2013) Submission no 4 to Senate Community Affairs References Committee, Parliament of Australia, 'Impacts on Health of Air Quality in Australia', pp5,8; World Health Organization, (2003) 'Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide', Report on WHO Working Group pp5-6.
[4] Yang and Chou (2017) 'The Impact of Environmental Regulation on Fetal Health: Evidence from the Shutdown of a Coal-Fired Power Plant Located Upwind of New Jersey' https://www.sciencedirect.com/science/article/pii/S0095069617306381?via%3Dihub
[5] See for example – 'Traffic-related air pollution exposure is associated with allergic sensitization, asthma, and poor lung function in middle age' https://www.ncbi.nlm.nih.gov/pubmed/27372567; and 'Traffic-related air pollution exposure over a 5-year period is associated with increased risk of asthma and poor lung function in middle age.' https://www.ncbi.nlm.nih.gov/pubmed/29074540 and 'The Dose-Response Association between Nitrogen Dioxide Exposure and Serum Interleukin-6 Concentrations.' https://www.ncbi.nlm.nih.gov/pubmed/28481326
[6] Qian et al. 'Air Pollution and Mortality in the Medicare Population.' http://www.nejm.org/doi/full/10.1056/NEJMoa1702747
[7] Wang et al. 'Association of Long-term Exposure to Airborne Particulate Matter of 1 µm or Less With Preterm Birth in China' https://www.ncbi.nlm.nih.gov/pubmed/29297052

which are particularly hazardous to human health[8]. Additionally for the power stations in the Latrobe Valley, coarse particle pollution (PM_{10}) from the associated and co-licenced mines are a significant pollution source in the Latrobe Valley. The total health burden of coal pollution – including the costs of asthma, respiratory and cardiovascular diseases, lung cancer, and many other illnesses – is estimated at $2.6 billion per year.[9]

KEY ISSUES AND RECOMMENDATIONS FOR THIS REVIEW

The following issues are the areas of concern that must be addressed in this review:

1. The EPA must amend licences to dramatically reduce the toxic pollution from the power stations.

Problem:

We understand that, to date, the EPA has considered the emissions from the power stations are acceptable from a health perspective because ground level concentrations of pollution generally do not exceed national ambient air standards. Putting aside the fact that emissions do exceed national standards at times, there are two issues with this from a health perspective:

- all State, Territory and Commonwealth governments have acknowledged that death and disease occurs at well below the Australian standards and that there is no safe level for $PM_{2.5}$ in particular.

- in the case of sulfur dioxide (SO_2), Australia's ambient air standards are incredibly lax compared to other jurisdictions including the US. Australia has not reviewed its SO_2 and NOx standards for 20 years and is well behind the rest of the world on this. The US EPA has determined that ambient SO_2 above 75 ppb hourly average does not protect environmental or public health, however Australia's standard for hourly average concentration is 200 ppb.

Therefore in order to protect the health of the Latrobe Valley community, and people further afield, emissions must be reduced to the lowest concentration possible.

Attachment 1 contains a statement from Dr. Ranajit (Ron) Sahu, Ph.D., QEP, CEM Engineer & Air Quality Consultant which analyses the emissions of the Latrobe Valley power stations (as far as he was able with the limited data available) and the pollution control technologies that the power stations should be installing. Dr Sahu's key points are summarise below:

- At present it appears that the locations of the current monitors are not adequate to properly characterize all of the exposures to contaminants in ambient air.

[8] National Pollutant Inventory (2017) Department of Environment and Energy, Australian Government http://www.npi.gov.au/home
[9] Tom Biegler, 'The Hidden Costs of Electricity: Externalities of Power Generation in Australia' (Report, Australian Academy of Technological Sciences and Engineering, March 2009)

- There are no technological barriers to designing pollution control systems for the brown coals burned at the three plants.

- SO_2 emission controls are simply insufficient at all three power plants.

- Ambient SO_2 levels allowed in Victoria are nearly three times greater than that considered adequate to protect public health and the environment in the United States.

- Hourly average SO_2 levels between 2005 to 2015 at Jeeralang Hill exceeded the already generous Victorian ambient air quality standard in five out of eight reported years. Maximum hourly average ambient SO_2 levels at Jeeralang Hill exceeded Victoria's standard 14 out of the 15 years between 2000 and 2015.

- The license limit for SO_2 from Loy Yang B is far above best practice for power plants.

- Relicensing should require maximum reduction of SO_2 with the addition of wet Flue Gas Desulfurization (FGD) using limestone ($CaCO_3$) or similar reagents for 99% removal efficiency.

- NOx generation should be minimized and reduction should be maximized at the three power plants through a range of methods including low NOx burners and selective catalytic reduction.

- Total NOx emissions from the three plants was 50,584 tonnes (approximately 55,642 short tons). By way of comparison, even the lowest NOx emitter of the three plants – Yallourn – would rank #264 (out of 306) coal-only burning units in the US in 2016. Loy Yang B at 1.76 kg/MWh NOx would rank #298/306.

- Victorian ambient air standards for PM_{10} and $PM_{2.5}$ are very stringent. That said, ambient levels in the Latrobe Valley for PM are of concern. PM reduction from the plants should be maximized with a fabric filter/baghouse to reduce over 99.6% of particles less than 1 μm and over 99.95% of particles greater than 10 μm.

- CO_2 capture and sequestration from thermal coal-fired power plants is not widely used at the present time, and appears unlikely to become widely viable or reliable, particularly when it comes to long-term carbon sequestration. Clean energy, zero carbon alternatives to coal plants should be considered for maximum reduction of CO2 emissions.

- Dr Sahu estimates the plants have emitted over 113 tonnes of mercury since operations began, and will emit almost 80 more tonnes in the coming decades. Dr Sahu estimate the three power plants are emitting roughly 3.3 tonnes of mercury per year whereas in the US power stations are required to emit a maximum of 0.6 tonnes of mercury per year or less.

- Without the use of mercury-specific pollution controls, there is minimal control of mercury emissions from power plants burning lignite or brown coal. Different upgrades required for Australian coal-fired power plants to meet best available technology/best environmental practice guidance under the Minamata Convention, includes fabric filters, activated carbon injection and disposal, FGD, and SCR.

As Dr Sahu states in Attachment 1, the only way to achieve significant reductions of major pollutants is by using the best available technologies for post combustion pollution controls for major pollutants. "This means using wet flue gas desulfurization (wet FGD) technology to remove 99.95% of SO_2 emissions; Selective Catalytic Reduction (SCR) to remove 95% of NOx, installation of a baghouse/fabric filter for 99.95% particulate matter removal (as opposed to less efficient electrostatic precipitator (ESP) technology); and the use of additional mercury

controls, such as activated carbon injection, for removal of 90% of mercury".[10] None of the three Latrobe Valley power stations have these controls. Alarmingly though, it appears that none of the power stations even have the second tier pollution controls that are installed in NSW and Queensland such as low NOx burners.

The EPA and industry often cite this as being because Victoria has low sulfur and low mercury coal. However as demonstrated in Dr Sahu's analysis, an examination of the emissions of the power stations shows that in fact the sulphur dioxide and mercury emissions of the power stations are significant, due to the sheer volume of coal that is burnt each year, over 40 plus years.

The reality is that Victorian power stations are far behind the rest of Australia and the world in their pollution reduction technology, and they are consequently emitting much more toxic pollution. It is clear that since privatisation the power station operators have been allowed to cut costs by not installing or upgrading pollution control technologies, because the EPA has not required them to do the necessary upgrades. Alinta's public statements[11] since purchasing Loy Yang B for over $1 billion dollars demonstrate that they intend to continue this approach in order to cut electricity retail costs to gain a greater market share of Australian electricity customers. Alinta has stated that it intends to run Loy Yang B until 2047. AGL has stated it will run Loy Yang A until 2048. If these power stations are going to operate another 30 years at great profit, they should be required to make the necessary upgrades to ensure they do not continue to emit these levels of pollution for another 30 years.

The EPA has authority to include stricter emissions limits in power station licences via the *Environment Protection Act 1970* (EP Act) and relevant State Environment Protection Policies. There is nothing in the EP Act, or the State Environment Protection Policies, that indicates that EPA cannot require further emission reductions once ambient air standards are generally being met (if indeed they are). To the contrary, the EP Act and SEPP AQM give specific power to do regulate for continuous improvement to achieve cleaner air, particularly when technologies to do so are readily available.

In our opinion, the EPA has power to require emissions reductions much greater that those it is currently employing. We would be happy to discuss this analysis with you further.

Recommendation:

1.1 The EPA must amend all three licences to achieve international best practice emissions limits for the power stations with the aim of reducing emissions to as low as possible to protect human health.

[10] Dr Ron Sahu, 'Recommended Retrofits for Loy Yang A, Loy Yang B, and Yallourn Power Plants' at Attachment 1 pg 2
[11] See for example Australian Financial Review, 'Alinta Energy to challenge AGL, Origin after Loy Yang B purchase' http://www.afr.com/business/energy/electricity/alinta-energy-to-challenge-agl-origin-after-loy-yang-b-purchase-20180112-h0h9s9

2. EPA must consider climate change and regulate greenhouse gas emissions

The problem

Under the *Climate Change Act 2017* the EPA is required to consider climate change in making any decision to amend the power station licences.[12] In fulfilling this requirement, the EPA must acknowledge the fact that the three power stations are by far the biggest emitters of greenhouse gases in Victoria and therefore the "potential contribution to the State's greenhouse gas emissions of the decision"[13] is incredibly significant.

It is now beyond doubt that the EPA has power "to regulate the emission and discharge of greenhouse gas substances to reduce harm to the environment".[14] The EPA must use this power to regulate the greenhouse gas emissions of the Victorian power stations as part of this licence review.

Recommendation:

2.1 The EPA should regulate greenhouse gas emissions from the power stations in accordance with its powers under the EP Act.

3. EPA must rapidly move to a Load Based Licencing scheme

The problem:

The EPA does not provide any incentive for power stations to reduce their emissions beyond what they are licenced to emit. Therefore there is no financial incentive for power stations to upgrade their pollution reduction technologies or operate the pollution control technologies they have more effectively.

Load based licencing schemes like the one in NSW require polluters to pay licences fees based on the amount of their emissions. The scheme provides a financial incentive for polluters to reduce their emission below their licence limits, and rewards those who are reducing their emissions for any reason. This is an effective management approach to ensure that polluters are bearing the cost of their pollution (as the Environment Protection Act and SEPPs require) rather than pushing it on to local communities as health costs, and allows polluters to determine the most cost effective way of doing so.

Recommendations:

3.1 The Victorian Government should move toward adopting a Load-Based Licencing scheme by removing legislative barriers, consistent with the recommendations of the 2015 Independent Inquiry into the EPA.[15] In the Victorian Government's response to that inquiry, the Government agreed that the new Environment Protection Act should

[12] As a decision under s20 of the EP Act, as per schedule 1 of the *Climate Change Act 2017*
[13] s17(2)(b) *Climate Change Act 2017*
[14] EP Act s13(1)(ga)(ii)
[15] See Inquiry report recommendation 16.1 http://epa-inquiry.vic.gov.au/epa-inquiry-report

allow for Load Based Licencing[16]. However that legislation will not be in force and implemented for a number of years (if it passes Parliament) and therefore government should amend the current Environment Protection Act in the interim to allow the EPA to move to a Load Based Licencing scheme as a priority.

3.2 In developing a Load Based Licencing Scheme, the EPA should ensure that the fees are set at a level that effectively incentivises emission reduction and internalises the cost of the pollution. Although the NSW scheme is structurally sound, the fees are set much too low and have not incentivised pollution reductions in the power stations (as evidenced by the fact that none of the NSW power stations have installed significant new pollution reduction technologies to reduce their emissions for many years). It has been estimated that the NSW scheme would have to increase by a factor of 50 to properly internalise the health costs created by the NSW power stations.[17]

4 EPA must improve licence conditions regarding the monitoring and reporting of emissions

The problem:

The licences for all three power stations merely state – "You must implement a monitoring program that enables you and EPA to determine compliance with this licence" (LI_G5). Monitoring of power station stack emissions is inadequate, as is reporting of those emissions to the EPA and to the community. In NSW, by law and as a condition of a power station's licence all power stations must put emissions data on the website and provide it to any person on request within two weeks. Our requests have taken months. Further, the fact that a private industry group (LVAMN Inc) operates two of the ambient air monitoring stations and is not required to publish that data or provide it on request to the community is inadequate. The data that the LVAMN currently publishes is incomplete (e.g. no data for Rosedale South monitor) and is not in a form that can be analysed (i.e. full datasets). Commercial in confidence claims in relation to monitoring data are spurious – in NSW these objections are clearly not countenanced by the NSW EPA and should not be in Victoria either.

Recommendations:

4.2 The EPA should amend licences for all three power stations to require continuous automatic emissions monitoring from all stacks for NOx, SO_2, PM_{10}, $PM_{2.5}$ and mercury (as recommended by the World Bank[18]) with a requirement that the data be released publicly in real time. Full datasets should be verified by the power station operators and available within 14 days to any person on request. The EPA should ensure data is available as downloadable datasets so the community has access to the information and

[16] See Government Response to EPA Inquiry pg23 https://www.environment.vic.gov.au/sustainability/independent-inquiry-into-the-epa

[17] See Doctors for the Environment Australia https://www.dea.org.au/wp-content/uploads/2017/02/NSW-Review-of-the-load-based-licensing-scheme-submission-12-16.pdf

[18] World Bank Group/International Finance Corporation, Environmental, Health and Safety Guidelines Thermal Power Plants, Draft for Second Public Consultation (May/June 2017) http://www.ifc.org/wps/wcm/connect/9a362534-bd1b-4f3a-9b42-a870e9b208a8/Thermal+Power+Guideline+2017+clean.pdf?MOD=AJPERES at 36.

can independently analyse it. Power station operators should be required to test their stacks annually and to ensure that the continuous monitors are functioning properly.

4.3 The EPA should obtain all monitoring data from the ambient air monitoring stations in the LVAMN and have it available on its website as downloadable datasets within 14 days of the data being recorded as occurs in NSW.

5 EPA must improve the management and compliance of dust emissions from mines

The problem:

Dust from the coal mines located adjacent to the power stations is not being adequately regulated, monitored and enforced. We and others in the community have observed very large clouds of dust being blown beyond the boundary of the sites on windy days. When reporting such incidences to the EPA we have been informed that it is unclear whether the EPA or Department of Economic Development Jobs, Transport and Resources Victoria (DEDJTR) has responsibility for the emissions. This is surprising given the EPA's Protocol for Environmental Management: Mining and Extractive Industries[19] (PEM) which states "EPA has the primary role for pollution prevention and control, whilst other government departments and agencies have other responsibilities to ensure SEPP objectives are attained"

As far as we are aware, beyond asking the mines to investigate the issue, no further action has been taken.

The licences are almost silent on the issue of dust emissions from the mines. All three licences have a condition power station operators "must ensure that nuisance dust and/or nuisance airborne particles are not discharged or emitted beyond the boundaries of the premises." (LI_A3). Clearly this licence condition is being breached on days where visible dust emissions are leaving the boundaries of the sites, with no enforcement action being taken. However the repeated occurrences of dust events indicates that that much better management conditions are also required to prevent dust emissions from occurring in the first place.

Recommendations:

5.1 The EPA should take responsibility for the management of these emissions by including much more prescriptive licence conditions to prevent dust emissions in the power station licences. We refer to you to the 2011 Katestone Environmental report *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* for international best practice measures. The Victorian Government should consider updating the PEM and including the most critical measures in the licences.

5.2 The EPA should take responsibility for compliance of dust emission requirements by actively enforcing them. This should not be left to DEDJTR, an agency that is unlikely to take such enforcement action.

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[19] EPA's Protocol for Environmental Management: Mining and Extractive Industries http://www.epa.vic.gov.au/~/media/Publications/1191.pdf

6 Groundwater Contamination Management and Monitoring from Coal Ash dumps

The problem:

Consecutive environmental audits for both Yallourn and Loy Yang ash ponds have outlined that the ash ponds are a source of groundwater contamination and that the monitoring programs for groundwater contamination are inadequate to determine the scale and severity of the contamination.[20] At Loy Yang, the groundwater contamination under the ash ponds is so bad that the EPA designated the groundwater table underneath the ash ponds a "Groundwater Attenuation Zone" (GAZ) in 2001. As far as we are aware, EPA has not required Loy Yang's operator to undertake any remediation or specific management of this contamination other than to undertake groundwater monitoring.

Information regarding groundwater contamination at Hazelwood is unknown as there are no environmental audits for Hazelwood available on the EPA website.

The EPA reviewed the licence conditions for landfill throughout 2016-2017[21] (including the Yallourn and Loy Yang ash dumps) which resulted in revised licence conditions.[22] However the only stakeholders consulted in this process were license holders.[23] Having reviewed the licence conditions for Yallourn and Loy Yang, the landfill licencing scheme, the *State Environment Protection Policy (Groundwaters of Victoria) 2002* (Vic), the environmental Audits for Loy Yang and Yallourn, and having had discussions with a coal ash management expert, we are of the opinion that the current licence conditions regarding ash ponds are not adequate to protect land and water contamination, even as amended.

The EPA had the opportunity and the legal basis to implement licence conditions to facilitate stricter monitoring, mitigation, and clean-up of extant groundwater pollution or suspected groundwater pollution from the ash ponds at both Yallourn and Loy Yang, and to require progressive rehabilitation of ash ponds that are no longer in use. These amendments could have been dealt with if the EPA had consulted with stakeholders other than licence holders during the landfill licence review process. The 2017 amended conditions are inadequate and should be revised.

Recommendations:

6.1 EPA should include specific licence conditions for groundwater contamination monitoring at the ash pond landfill sites. The amended licence condition licence condition LI_L1.1 is

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[20] Golder Associates, Report Number 117616111-026-R-Rev0, Yallourn Landfills, 53V Audit, Yallourn Ash Landfill, Hard Waste Landfill and asbestos Landfill, Submitted to Victorian Environment Protection Authority, 27 October 2017; Golder Associates, Report Number 117616111-015-R-Rev3, Yallourn Landfills, 53V Audit, Yallourn Ash Landfill, hard Waste Landfill and Asbestos Landfill, Submitted to the Victorian Environment Protection Authority, 17 September 2015; Ernst and Young, EPA Service Order No. 8005209, AGL Loy Yang S 53V Statutory Audit of Ash Landfill Operations Final Report, Submitted to the Victorian Environment Protection Authority, 27 June 2017; Ernst and Young, EPA Service Order No. 8004546, AGL Loy Yang A 53V Statutory Audit of Ash Landfill Operations Final Report, Submitted to the Victorian Environment Protection Authority, 30 June 2015. Available at http://www.epa.vic.gov.au/our-work/environmental-auditing/environmental-audit-reports-online

[21] See: http://www.epa.vic.gov.au/our-work/programs/landfills-improvement-program.

[22] See: http://www.epa.vic.gov.au/our-work/programs/~/media/Files/Our%20work/Programs%20and%20initiatives/Landfills%20improvement%20program/Final-Landfill-Conditions-EPA-07102016-PDF.pdf

[23] See: http://www.epa.vic.gov.au/our-work/programs/landfills-improvement-program#Response.

inadequate. While it provides more detail than the previous condition on the monitoring requirements that must be met, the risks posed by ashponds to groundwater, and the inadequacies of current monitoring programs identified in environmental audits, indicate that specific licence conditions for groundwater monitoring, management of contamination sources, ongoing hydrogeological assessment, and plume migration mitigation strategies outside the GAZ boundary at Loy Yang need to be implemented.

6.2 EPA should impose specific licence conditions that sources of groundwater contamination are adequately managed and, where practicable, cleaned up. In particular, management of the Loy Yang Groundwater Attenuation Zone needs to be more stringent than just monitoring the migration of the contamination plume.

6.3 All groundwater monitoring information should be made publicly available as downloadable datasets. Groundwater contamination information, including reports on plume management and migration at Loy Yang and hydrogeological assessments, should be publicly available.

7 Closure and rehabilitation bonds

The problem:

As far as we are aware, the EPA still has not imposed financial assurances on the power stations' coal ash waste dumps as it is required to do. This should be finalised as a priority.

However it is not enough to place financial assurances merely on the coal ash dumps. The EPA should seek amendment of the EP Act to enable it to place financial assurances on the facility itself, to ensure the substantial costs of rehabilitation and decommissioning the power station including the toxic materials contained within and around it are covered, and the Victorian public are not left with a toxic legacy or a multimillion dollar clean up bill.

Recommendation:

7.1 The Victorian Government must establish standards and guidelines for decommissioning and rehabilitation of coal ash dams, and hold bonds from generators to ensure these best practices are implemented.

8 Concerns about this review process

We feel compelled to comment on the process of this licence review as we believe it has been inadequate and not befitting of a 'world class regulator'. When the EPA made the sound decision to conduct period reviews of licences every five years, it should also have considered the role that stakeholders other than the licencee should play in the review. As the three largest emitters of NOx, SO_2, $PM_{2.5}$, PM_{10} and greenhouse gases in the State, and given their proximity to communities in the Latrobe Valley, the review of the licences of the Latrobe Valley power stations is legitimately a matter of public interest. The EPA commenced this review privately with the power station operators and with no notification to any other stakeholder that it was occurring or an invitation to be involved.

Even after strong urging from our organisation and others that the EPA invite public submissions the EPA has refused to do so, and indicated that it would only accept submissions from a small list of

organisations. We commend the EPA for its commitment to holding a section 20B conference but believe that written submission should have been open to any interested party.

The other area in which the EPA's conduct has been far below that of a world class regulator is in relation to provision of information to assist public interest groups such as ours to participate on behalf of the wider community. We have repeatedly requested the EPA provide us with stack emissions data from the power stations, ambient air data from the LVAMN, and ambient air data from the EPA's own monitoring stations to enable us to independently analyse the data and fully participate in this review, but this was not provided.

The EPA's admission that it does not hold not have access to the power stations' stack emissions data is alarming. The EPA's requirement for us to do an FOI request for what little information they do hold has meant that the data has been delayed by months, and only received this week. Our requests to the power station operators directly to provide stack emissions data to us has been ignored in the case of Alinta and EnergyAustralia. To their credit AGL responded to our request and provided us with limited data (although not the full data that we requested).

This submission has therefore been prepared without access to the full information needed and we have had to spend many hours searching for and compiling scraps of emissions data that we could find in public reports. The EPA's requirement for the power stations to conduct their own modelling of emissions and provide it to stakeholders in April is welcome, but too late for written submissions and also does not provide the extent of information we need – that is the raw stack emissions data and ambient air data so we can independently analyse it. If the EPA is to be a world class regulator it needs to rectify these issues as a priority.

Recommendation:

8.1 The EPA should engage an independent evaluation of the community engagement practices and protocols reflected in this licence review, with recommendations to strengthen engagement practices in the future. The review should be circulated to the EPA board and the community for discussion.

LATROBE VALLEY COMMUNITY CONCERNS REGARDING POWER STATION LICENCES

On 7 February 2018 Environmental Justice Australia held a public forum in Traralgon to help people understand the licence review process and to capture their concerns to include in our submission. Approximately 30 people attended the forum. Participants provided their concerns verbally and were also able to complete an anonymous questionnaire, which 12 of the 30 participants completed.

The feedback we received via verbal responses and the questionnaire is summarised below.

- All questionnaire participants were concerned that EPA was not doing enough to reduce air emissions in Latrobe Valley.
- People responded that their biggest concerns regarding the power station licences are:
    - Stricter air pollution limits;

- Stricter water pollution limits (including groundwater);
- Licences should require continuous stack monitoring;
- Ensuring all monitoring and reporting data (both EPA and operator) is publicly available;
- Licences should make clear EPAs role in enforcing compliance re dust from mine ;
- Threats to groundwater contamination need specific licence conditions for monitoring, management of source of contamination, and clean up.

- Participants overwhelmingly expressed their hope that EPA would impose stricter and more robust licence conditions generally.
- There was an emphasised concern that continuous stack emissions monitoring and stricter air pollution limits would both be introduced into the licences, including during start up and shut-down periods of operation.
- The need for transparency in the monitoring process and reporting of monitoring data and reporting was identified by participants;
- Another theme that emerged was people's grave concerns for mercury contamination of waterways, either by direct discharge to water or through airborne emissions.

Comments from questionnaire respondents included:

- "Mercury pollution needs to be reduced to as near as possible [to zero] in a shortest [sic] time frame possible";
- "Monitoring must be well regulated to ensure data can't be manipulated by companies';
- "Real time monitoring [to be conducted] by EPA – not power stations themselves – for air pollution and water pollution that flows eventually to the Gippsland lakes";
- "[W]ill EPA feel constrained by risk of another power station shut down if strict standards enforced?"

We are happy to discuss further any of the community responses.

For more information or to discuss this submission please contact:

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Attachment 1

Recommended Retrofits for Loy Yang A, Loy Yang B, and Yallourn Power Plants

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This document discusses possible retrofits for the three existing coal-fired power plants in the Latrobe Valley of Victoria, Australia: Loy Yang A (2210 MW, built in 1984); Loy Yang B (953 MW, built in 1994, expected to increase to 1140 MW in 2019); and Yallourn (1480 MW, built in 1974).[1] 95% of air pollution in the Latrobe Valley is from the coal-fired units at these power plants.[2]

I have over 30 years of experience in environmental, mechanical, and chemical engineering including extensive experience with design and specification of pollution control equipment at thermal coal plants. (See Appendix for a partial curriculum vitae. My full CV is available upon request.)

I have reviewed the power station sites, publicly available ambient air data, topography, and meteorological conditions in the Latrobe Valley, the Jacobs 2016 report for Loy Yang B expansion, Environmental Justice Australia's analysis of power station emissions in the Toxic and Terminal report of 2017, and other relevant studies as cited in this document.

1. Ambient Air and Stack Monitoring

Existing **ambient air monitoring** in the Latrobe Valley, where the aforementioned coal-fired power plants are sited in addition to other large industrial sources, is inadequate in several respects. I understand that the EPA is aware of this and has been through a process to determine a new monitoring network which is being implemented this year. At present it appears that the locations of the current monitors are not adequate to properly characterize all of the exposures to contaminants in ambient air. For example, the wind roses in Jacobs (2016) show primarily westerly winds,[3] but neither the EPA Traralgon nor LVAMN Jeeralang Hill monitoring stations are located east of the power plants. The LVAMN Rosedale South monitoring station is northeast

[1] Environmental Justice Australia, Toxic and Terminal (2017) (hereinafter "EJA, Toxic and Terminal"), https://envirojustice.org.au/sites/default/files/files/EJA_CoalHealth_final.pdf.

[2] *Id*., at 10, citing Bernard Teague *et al.*, Hazelwood Mine Fire Inquiry Report 2015/2016.

[3] Jacobs, Works Approval Application – Turbine Retrofit Project Proposal (5 September 2016), Appendix F.1 (LYB Upgrade – Air Quality Impact Assessment – AERMOD) (hereinafter "Jacobs, LYB Upgrade AQIA"), at Figure 3-3 and Appendix B.

and potentially more relevant, but is not currently reporting data. To assist in rectifying these inadequacies, first, a thorough community-based exposure-driven set of ambient air monitors should be established – with monitoring for ozone, NOx, SO_2, and PM_x (where x = 10 and 2.5) as well as for pollutants such as mercury and additional pollutants such as organics depending on proximate source emission profiles. Second, the results of such ambient monitoring should be publicly reported via a website that not only provides the current level of emissions but also the historical record, in a downloadable format. A proper monitoring network is especially critical given the fairly lenient ambient air standards applicable in the Latrobe Valley.

Stack emissions of SO_2, NOx, CO_2, and mercury should be continuously and automatically monitored, as they are in the United States.[4] Hourly mass emissions data along with boiler heat input and generation data should be made public 30 days after each prior calendar quarter after proper quality assurance and permanently archived for public access.[5] Licenses should also require facilities to test their stacks annually and to ensure that the continuous monitors are functioning properly.

2. Pollutant-Specific Controls

There are no technological barriers to designing pollution control systems for the brown coals burned at the three plants. Significant reductions of major pollutants can only occur by using the best available technologies for post combustion pollution controls for major pollutants. This means using wet flue gas desulfurization (wet FGD) technology to remove 99.95% of SO_2 emissions; Selective Catalytic Reduction (SCR) to remove 95% of NOx; installation of a baghouse/fabric filter for 99.95% particulate matter removal (as opposed to less efficient electrostatic precipitator (ESP) technology); and the use of additional mercury controls, such as activated carbon injection, for removal of 90% of mercury.

The World Bank draft guidelines of 2017 similarly note:

> More minor changes to improve environmental performance [of existing thermal power plants] would include fitting of low-NOx burners; and injection of urea or ammonia (for either SNCR or SCR) for NOx control; addition of post-combustion alkaline reagent injection (dry; semi-dry; or wet FGD) for SO_2 and HCl control; injection of activated carbon to capture heavy metals and dioxins/furans; and improvement of particulate control measures by adding cyclones and fabric filters. Turbine steam extractions or other heat recovery methods could also be added in order to serve newly connected thermal loads (cogeneration).[6]

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[4] World Bank Group/International Finance Corporation, Environmental, Health, and Safety Guidelines for Thermal Power Plants (Draft for Second Public Consultation – May/June 2017) (hereinafter "WB/IFC Guidelines"), at 36, http://www.ifc.org/wps/wcm/connect/9a362534-bd1b-4f3a-9b42-a870e9b208a8/Thermal+Power+Guideline+2017+clean.pdf?MOD=AJPERES.

[5] Per the US Clean Air Act Title VI (41 USC §7651-7651), under which any power plant more than 25MW has been reporting hourly generation, mass emissions of SO_2, NOx, CO_2, and heat input (mmBTu/hr). Some power plants now also report hourly mercury emissions pursuant to the Mercury and Air Toxics Rule.

I now discuss each of the pollutant-specific air pollution controls that should be considered at the coal-fired units of the three power plants.

2.1 Sulphur Dioxide (SO_2)

SO_2 emission controls are simply insufficient at all three power plants.[7] Emissions intensities for SO_2 are particularly high at Loy Yang A and Loy Yang B even compared to other Australian plants, and are much higher than similarly sized, older power plants in the United States, for example, which have been retrofitted with SO_2 controls (see Table 1 below).

The current[8] ambient SO_2 level allowed in Victoria (200 ppb for 1 hr, not to be exceeded on more than one day per year[9]) is far less stringent than that considered adequate to protect public health and the environment in the United States (75 ppb for 1 hr[10]). In Jacobs (2016), Jeeralang Hill data indicate that hourly average SO_2 levels between 2005 to 2015 exceeded the already generous Victorian ambient air quality standard in five out of eight reported years.[11] Jacobs (2016) also shows maximum hourly average ambient SO_2 levels at Jeeralang Hill exceeded Victoria's standard 14 out of the 15 years between 2000 and 2015.[12]

Jacobs (2016) concluded that "the likely sources of the highest SO_2 concentrations observed in the sector ENE-to-E would have been the nearby Loy Yang power stations."[13] I reviewed online hourly SO_2 monitoring by the Latrobe Valley Air Monitoring Network (LVAMN) station at Jeeralang Hill for December 2017 and January 2018 – *i.e.*, well after the shutdown of the Hazelwood power plant. There are sporadic peaks of SO_2 reaching 250ppb.[14] Without publicly available wind data for the Latrobe Valley for all hours from various locations and altitudes, it is

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[6] WB/IFC Guidelines, at 61.

[7] EJA, Toxic and Terminal, at 35.

[8] I understand that EPA Victoria is in the process of reviewing this standard and that it may be lowered in the future. *See* EPA Victoria, Review of national ambient air quality standards (hereinafter "EPA Victoria, Review of air standards"), http://www.epa.vic.gov.au/your-environment/air/review-of-national-ambient-air-quality-standards.

[9] EPA Victoria, Sulfur dioxide in air, http://www.epa.vic.gov.au/your-environment/air/air-pollution/sulfur-dioxide-in-air.

[10] The US SO_2 hourly standard is 75 ppb. The 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years should not exceed this value. *See* US EPA, NAAQS Table, https://www.epa.gov/criteria-air-pollutants/naaqs-table.

[11] Jacobs, LYB Upgrade AQIA, Figure 4-3.

[12] *Id*., Figure 4-4.

[13] *Id*., text below Figure 4-2.

[14] *See* LVAMN Daily Graphs, available at http://lvamninc.com.au/graphs.php; example; http://lvamninc.com.au/graphs.php?arched=1&type=SO2&exact=14122017. SO_2 spikes of 250ppb occurred on 13 and 22 December 2017 and 6 January 2018.

not possible to determine the origin or longevity of these SO_2 plumes, only that they are occurring and potentially exposing and harming humans.

The license limit for SO_2 from Loy Yang B is also far above best practice for power plants. In the United States, permit limits for SO_2 (and most other air pollutants) from power plants are typically expressed in mass per unit heat input terms (*i.e.*, pounds of SO_2 per million Btus of heat input or pounds of SO_2 per MWh of electricity generated), rather than in mass per unit time terms. While mass per unit time is better than a concentration (*i.e.*, mg/m3, etc.) form of the limit, it still improperly allows much higher emissions when heat inputs are low, unlike at US plants. SO_2 emissions from retrofitted, older power plants in the US often reflect SO_2 reductions of well above 99% from SO_2 levels associated with the incoming coal. Table 1 below shows existing (2016 data) for selected coal units in the US achieving SO_2 emissions levels of below 0.03 pounds per million Btu or less than 0.3 pounds per MWh. These levels generally represent over 95%, and in many cases over 99%, SO_2 controls compared to the sulfur levels in the incoming coals burned at these units.

Table 1: SO_2 Emissions (2016) from Various US Plants

State	Facility Name	Operating Time	Gross Load (MW-h)	Heat Input (MMBtu)	SO_2 (short tons)	SO_2 (lb/MMBtu)	SO_2 (lb/MWh)
IL	Duck Creek	7177.05	2338467	2.35E+07	9.899	0.000844	0.008466
IL	Coffeen	7241.05	3436013	3.32E+07	20.45	0.001231	0.011903
IL	Coffeen	5910.55	1645863	1.53E+07	12.886	0.001681	0.015659
MO	Iatan	8353.03	5420627	5.44E+07	110.604	0.004065	0.040809
MO	Iatan	6060.82	5029214	4.47E+07	138.943	0.00622	0.055254
TX	J K Spruce	5550.25	3248413	3.21E+07	150.835	0.009396	0.092867
TX	Gibbons Creek Steam Electric Station	6986.02	1779195	1.98E+07	198.221	0.020034	0.222821
KS	Jeffrey Energy Center	6099.13	2936728	3.17E+07	320.112	0.020224	0.218006
GA	Scherer	8709.75	4550262	4.41E+07	448.967	0.020347	0.197337
GA	Scherer	8168.25	4426621	4.60E+07	473.464	0.020585	0.213917
GA	Scherer	7469	4240476	4.43E+07	461.731	0.020851	0.217773
MN	Boswell Energy Center	8411.52	4627921	4.72E+07	553.528	0.023471	0.239212
KS	Jeffrey Energy Center	8130.39	4472451	4.51E+07	544.749	0.024154	0.243602
GA	Scherer	7499.5	4804934	4.97E+07	600.362	0.024158	0.249894
KS	La Cygne	7826.55	4903721	4.71E+07	576.985	0.024515	0.235325

Relicensing should require maximum reduction of SO_2 with the addition of wet Flue Gas Desulfurization (FGD) using limestone ($CaCO_3$) or similar reagents for 99% removal efficiency,[15] and the wet FGD system should be operated for maximum efficiency and required to be in use whenever coal is burned.

While wet FGD systems are relatively expensive, these plants are expected to run for decades into the future, so capital investments should be recoverable. Lower levels of SO_2 reduction are possible, with corresponding lower capital costs, using dry scrubbers with efficiencies up to 94%[16] – available in a variety of configurations. At a minimum, SO_2 reduction approaches such as coal cleaning (typically at the mine, where sulfur containing impurities are removed from the coal before it is processed for combustion) as well as Dry Sorbent Injection (DSI),[17] could provide SO_2 reduction up to 90% (but often much lower)[18] at lower capital costs.

2.2 Oxides of Nitrogen (NOx - *i.e.*, NO and NO_2)

NOx generation should be minimized and its subsequent reduction should be maximized at the three power plants. First, NOx generation should be minimized using a combination of ultra low NOx burners (ULNB), along with separated over-fire air (SOFA or a variant appropriate for each boiler) introduction into the boiler and the use of adaptive neural network controls to continually keep NOx generation low. Other approaches such as use of low excess air (LEA) firing or flue gas recirculation[19] can be used to minimize NOx generation as well. Thereafter, secondary reduction of NOx should be maximized with a Selective Catalytic Reduction (SCR) system, with removal efficiencies up to 95%.[20] SCR catalysts do contain heavy metals that require proper handling and eventual disposal. At a minimum, in addition to the NOx generation minimization approaches (*i.e.*, ULNB, SOFA, and adaptive neural networks) which have very modest capital costs, the plants should consider using Selective Non-Catalytic Reduction (SNCR) – in which a reducing agent such as ammonia is injected at the proper location in the boiler to effect NOx reductions of 25-40%.

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[15] Anthony L Morrison *et al.*, Analysis of Pollution Control Costs in Coal Based Electricity Generation – Technology Assessment Report, Cooperative Research Centre for Coal in Sustainable Development (January 2008) (hereinafter "Morrison 2008"), at 26, https://www.researchgate.net/publication/237460048_ANALYSIS_OF_POLLUTION_CONTROL_COSTS_IN_COAL_BASED_ELECTRICITY_GENERATION_TECHNOLOGY_ASSESSMENT_REPORT_68 ("A high velocity limestone with forced oxidation wet FGD system is capable of removing 99.6% of SO_2 under test conditions.").

[16] WB/IFC Guidelines, at 7.

[17] *See, e.g.*, Dr. R. Sahu, Technical Report on Dry Sorbent Injection (DSI) and Its Applicability to TVA's Shawnee Fossil Plant (SHF) (April 2013), at 1, http://www.cleanenergy.org/wp-content/uploads/Final_Sahu_DSI_Report.pdf.

[18] *Id. at 5.*

[19] WB/IFC Guidelines, at 6-9.

[20] Morrison 2008, at 115.

In any case, the reduction of NOx should be a high priority for these power plants. While neither the Victorian nor US EPA ambient standards for NOx were exceeded at two Latrobe valley monitoring stations analyzed in Jacobs (2016), that might reflect a monitor location problem more than anything. Emissions of NOx in 2015-16 were substantial: Loy Yang A emitted 1.31 kg NOx per MWh; Loy Yang B emitted 1.76 kg NOx per MWh, and Yallourn emitted 1.21 kg NOx per MWh.[21] Total NOx emissions in 2015-16 were 20,524 tonnes from Loy Yang A, 14,844 tonnes from Loy Yang B, and 15,216 tonnes from Yallourn. Total NOx emissions from the three plants was 50,584 tonnes (approximately 55,642 short tons).[22] Compared to the 306 coal-only burning power plant units in the United States as of 2016,[23] even the lowest NOx emitter of the three plants – Yallourn – would rank 264th in NOx emissions intensity in kg/MWh.[24] Loy Yang B's NOx emissions intensity would rank 298th out of 306.[25] It is also notable that the Victorian ambient air quality standard for NO_2 is less stringent than the US standard to protect public health and the environment. The Victoria EPA standard is 120 ppb for 1 hr,[26] compared to the US standard of 100 ppb for 1 hr.[27]

2.3 Particulate Matter (PM)

First, I commend the Victoria EPA for having one of the more stringent PM standards in almost any jurisdiction in the world. The annual PM10 standard is 20 µg/m3 and the 24-hour PM10 standard is 50 µg/m3.[28] As comparison, the US does not at present have an annual PM10 standard, and the US PM10 24-hour standard is significantly less stringent at 150 µg/m3.[29]

The Victoria PM2.5 ambient standards (*i.e.*, 25 µg/m3 on a 24-hour average and 8 µg/m3 on an annual average[30]) are also numerically very stringent. I understand that these standards may drop

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[21] *See generally*, Australian Government Department of the Environment and Energy, National Pollutant Inventory 2015/2016 (hereinafter "NPI 2015/2016"), http://www.npi.gov.au/.

[22] *Id*.

[23] There are approximately 306 units in the US at the present that burn only coal (as opposed to coal plus other fuels such as natural gas, etc.)

[24] Data taken from US EPA, Air Markets Program Data, www.epa.gov/ampd.

[25] *Id*.

[26] The one-hour standard should not be exceeded more than once (1 day) per year. *See* EPA Victoria, Nitrogen dioxide in air, http://www.epa.vic.gov.au/your-environment/air/air-pollution/nitrogen-dioxide-in-air.

[27] The US NOx (as NO_2) hourly standard is 100 ppb. The 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years should not exceed this value. *See* US EPA, NAAQS Table.

[28] *See* EPA Victoria, PM10 particles in air, http://www.epa.vic.gov.au/your-environment/air/air-pollution/pm10-particles-in-air.

[29] *See* US EPA, NAAQS Table.

to 20 µg/m3 and 7 µg/m3, respectively for the 24-hour and annual averages starting in 2025.[31] These standards are relatively stringent compared to the US standards (*i.e.*, 35 µg/m3 for 24-hour average and 12 µg/m3 for annual average[32]).

That said, ambient levels in the Latrobe Valley for PM are of concern. In data presented in Jacobs (2016), the 24-hour average PM10 statistics for the Traralgon ambient air monitoring station indicates that PM10 ambient standards of 50 µg/m3 were exceeded in eight of the past 13 years of monitoring.[33] I note that PM emissions are significant from not just the power plants but importantly from the coal mines in the Latrobe Valley. These fugitive PM emissions are often emitted at lower heights as compared to the tall stack emissions of the power plants. Thus, local PM emissions near the mines can be significant. Therefore, more air monitoring stations at/near the mines are essential to provide a representative picture of PM emissions.

PM reduction from the plants should be maximized with a fabric filter/baghouse to reduce over 99.6% of particles less than 1 µm and over 99.95% of particles greater than 10 µm.[34] Removal levels for particles between 1 and 10 µm would be between 99.6 and 99.95%. Fabric filters are simply much more effective at pollution reduction than electrostatic precipitators.[35] Compounding the problem, if DSI (for SO_2) and/or activated carbon injection (for mercury, as discussed later) are used as control strategies for those pollutants, then the existing ESPs will be further burdened and likely emit even more PM emissions.

2.4 Greenhouse Gases

CO_2 capture and sequestration from thermal coal-fired power plants is not widely used at the present time, and appears unlikely to become widely viable or reliable, particularly when it comes to long-term carbon sequestration.[36]

Australia has committed to reduce its greenhouse gas (GHG) emissions by 26-28% below 2005 levels by 2030.[37] Even with GHG intensity reduction planned at Loy Yang B, with new turbine

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[30] *See State Environment Protection Policy (Ambient Air Quality)*, Schedule 2, Table 1, http://www.epa.vic.gov.au/about-us/legislation/~/media/Files/about_us/Legislation/Air/160726consolidatedvariedSEPPAAQ.pdf.

[31] *See* EPA Victoria, Review of air standards.

[32] *See* US EPA, NAAQS Table.

[33] Jacobs, LYB Upgrade AQIA, Figure 4-5.

[34] WB/IFC Guidelines, at 6-9*;* Morrison *et al*., at 24.

[35] *Id*.

[36] *See, e.g.*, The New York Times, Companies Struggle to Make Carbon Capture Viable (October 2015) https://www.nytimes.com/2015/10/06/business/energy-environment/companies-struggle-to-make-carbon-capture-viable.html?mtrref=www.google.com&gwh=02FDE9339B1A1B0F7333ED532D596086&gwt=pay.

[37] Australian Government Department of the Environment and Energy, Australia's 2030 climate change target, http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target.

blades and seals planned for 2019, the total mass of GHGs emissions from the three thermal coal plants is set to increase, further harming the global climate. Again, mass emissions are the only metric of consequence as opposed to intensity of emissions. GHG reduction from the closure of the nearby Hazelwood power plant is not a credible mitigation of GHGs, as CO_2 impacts take place at the global scale over hundreds of years. Clean energy, zero carbon alternatives to coal plants should be considered for maximum reduction of CO_2 emissions.

2.5 Mercury

As far as I am aware, stack emissions of mercury have never been modelled or monitored from the Victorian power plants, nor is mercury monitored in ambient air quality, soils, surface water, groundwater, or biotic food webs where methylmercury may accumulate. For the most part, little systematic data is available for mercury emissions or impacts.

Mercury emissions from combustion sources have been recognized as a significant contributor to anthropogenic atmospheric emissions for many years.[38] Nelson *et al*. 2012 concludes that 14.8% of anthropogenic emissions in Australia of mercury result from coal combustion in power plants,[39] and mercury emissions from brown coal-fired power plants in Australia are significantly higher than those which use black coal.[40]

Without the use of mercury-specific pollution controls, there is minimal control of mercury emissions from power plants burning lignite or brown coal. For example, UNEP 2017 notes that mercury-specific controls on a lignite plant could reduce mercury emissions by 75%; however, an ESP alone on a lignite plant could reduce mercury emissions by only 2%, while PM control plus FGD and SCR together could reduce mercury emissions only by 20% combined.[41] In a similar study by US EPA, a cold side ESP system alone on a lignite-burning power plant did not show any reductions in mercury emissions while the addition of FGD reduced mercury emissions by only 44% combined.[42] Indeed, a report prepared in May 2015 for the Australian Government

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[38] P.F. Nelson, "Atmospheric emissions of mercury from Australian point sources," *Atmospheric Environment* 41 (2007) 1717–1724 (hereinafter "Nelson 2007"), at 1718.

[39] P.F. Nelson *et al.*, "Atmospheric mercury emissions in Australia from anthropogenic, natural and recycled sources," *Atmospheric Environment* 62 (2012) 291–302 (hereinafter "Nelson 2012"), at 293.

[40] Marsden Jacob Associates, Costs and benefits of Australia phasing down mercury – Report prepared for Department of the Environment (May 2015) (hereinafter "Marsden Jacob, Costs and benefits"), at 33 (Table 11), http://www.environment.gov.au/system/files/consultations/4068cac4-a2ba-4036-a9e0-7bdee4f558fd/files/final-report-cost-benefits-mercury.pdf.

[41] United Nations Environment Programme, Toolkit for identification and quantification of mercury releases, Reference Report and Guideline Report for Inventory Level 2, Version 1.4 (January 2017) (hereinafter "UNEP Toolkit"), at 65-66, Table 5-6, http://wedocs.unep.org/bitstream/handle/20.500.11822/14781/UNEP-Hg-Toolkit-Reference-Report-January2017.pdf?sequence=1&isAllowed=y.

[42] *Id*., at 65, citing US EPA, Control of mercury emissions from coal-fired electric utility boilers interim report (2002); *see also* Peter F. Nelson *et al.*, Mercury Sources, Transportation and Fate in Australia, Macquarie University and CSIRO (Revised April 2011), at 100,

Department of the Environment notes that the upgrades required for Australian coal-fired power plants to meet best available technology/best environmental practice guidance under the Minamata Convention, include fabric filters, activated carbon injection and disposal, FGD, and SCR.[43]

UNEP has estimated that the average mercury content of Australian brown coal is 0.068 g/tonne.[44] Roy 2016 also found the composition of Loy Yang coal used in experiments to be 0.06 mg/kg (equivalent to 0.06 g/tonne).[45] Estimations of mercury emissions from the three plants using these coal mercury contents are shown in Table 2.

https://wedocs.unep.org/bitstream/handle/20.500.11822/11592/AUSTRALIA_Hg_inventory_FINAL_REVISED_April_2011.pdf?sequence=1&isAllowed=y.

[43] Marsden Jacob, Costs and benefits, Appendix B Table 23.

[44] UNEP Toolkit, at 61.

[45] B. Roy and S. Bhattacharya, "Release behavior of Hg, Se, Cr and As during oxy-fuel combustion using Loy Yang brown coal in a bench-scale fluidized bed unit," *Powder Technology* 302 (2016) 328–332 at 329.

Table 2. Estimated mercury from Victorian power plants

Plant	Tonnes of coal per year (known for LYB; estimated for LYA and Yallourn)	Tonnes of Hg per year (using 0.068 g/tonne[46]	Years of operation	Tonnes of Hg emitted over operational lifetime to date	Years until planned closure	Tonnes of Hg likely to be emitted in the future
Loy Yang A	19.71 million[47]	1.34 tonne/yr	33	44.22	30	40.2
Loy Yang B	9.9 million (expanding to 10.233 million with planned expansion)[48]	0.67 tonne/yr	21 (both units)	14.07	30 (assumed)	20.1 (not including expansion)
Yallourn	18.92 million[49]	1.29 tonne/yr	43	55.47	14	18.06
Total	**48.53 million**	**3.3 tonne/yr**		**113.76**		**>78.36 with expansion of LYB**

I estimate the plants have emitted over 113 tonnes of mercury since operations began, and will yet emit almost 80 more tonnes in the coming decades. Yearly emissions estimated in Table 2 are significantly higher than those reported in the National Pollutant Inventory (NPI) (which, between July 2015 and June 2016, were 300 kg for Yallourn, 430 kg for Loy Yang A, and 380 kg for Loy Yang B).[50] This is not surprising given the findings in Nelson 2007, that the approach used in reporting mercury emissions to the NPI "significantly under-estimates emissions from brown coal fired power plant, if mercury capture efficiencies in these plants are low, as observed for lignite-fired plant."[51] Nelson 2007 suggests that the underestimates in the NPI result from emissions being reported using the NPI's generic emissions factor, which "is difficult to justify, unless

[46] UNEP Toolkit, at 61.

[47] Global CCS Institute and WorleyParsons, Post Combustion Carbon Capture – Thermodynamic Modelling (19 February 2013), at 5, http://hub.globalccsinstitute.com/sites/default/files/publications/91896/post-combustion-carbon-capture-thermodynamic-modelling.pdf. ("Electricity generation at Loy Yang A Power Station requires over 60,000 tonne of brown coal a day." 60,000 tonnes x 365 days per year = 21,900,000. I have assumed that Loy Yang A is in operation approximately 90% of the year: 21,900,000 x 0.9 = 19,710,000 million.)

[48] Jacobs, Works Approval Application – Turbine Retrofit Project Proposal (5 September 2016), at 22 and 1 ("LYB would consume up to an additional 323,000 tonnes of coal per annum").

[49] EnergyAustralia, Yallourn Power Station, https://www.energyaustralia.com.au/about-us/energy-generation/yallourn-power-station. ("Every hour 2400 tonnes of brown coal is used." 2400 tonnes x 24 hours per day x 365 days per year = 21,024,000. I have assumed that Yallourn is in operation approximately 90% of the year: 21,024,000 x 0.9 = 18,921,600.)

[50] *See generally*, NPI 2015/2016.

[51] Nelson 2007, at 1717. See also 1720-1722.

Australian brown coals behave quite differently from similar lignites for which extensive measures have been made."[52] See also Nelson *et al.* 2012[53] and Nelson *et al.* 2011.[54]

The Mercury and Air Toxics (MATS) Rule in the US requires new power plants burning low rank coal (like lignites) to emit mercury at less than 0.018 kg/GWh. As noted above in Table 2, I estimate the three power plants are emitting roughly 3.3 tonnes of mercury per year (NPI under-estimates this significantly as 1.11 tonnes) whereas the US MATS Rule would require them to emit a maximum of 0.6 tonnes of mercury per year or less (see Table 3).

Table 3. Victoria power plants mercury emissions compared to US MATS Rule

	GWh (2014-2015)[55]	Kg Hg/year	Kg Hg emitted per GWh (compare to US MATS standard of 0.018kg/GWh for low rank coal)	Max Kg Hg per year permitted by US MATS for low rank coal (0.018 kg/GWh)
Loy Yang A	16,275	1340	0.082	292.95
Loy Yang B	8,712	670	0.077	156.81
Yallourn	11,268	1290	0.114	202.82
Total		**3300**		**652.58**

Optimum mercury emissions reduction – beyond that provided by the FGD, fabric filter, and SCR systems discussed previously – requires the injection of various forms of powdered activated carbon (such as bromine-enhanced Powdered Activated Carbon (B-PAC)), or other sorbents.[56] Such activated carbon injection (ACI) systems can reduce mercury by 90%.[57]

3. Minimum Standards for Retrofit Assessment Process

I end my report by noting that the World Bank/International Finance Corporation recommends that, in assessing the retrofit of existing thermal power plants, any regulator should consider, at a minimum:

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[52] *Id*., at 1722.

[53] Nelson 2012, at 293.

[54] P.F. Nelson *et al.*, Mercury sources, transportation and fate in Australia – Final Report to the Department of Environment, Water, Heritage & the Arts (December 2009, revised April 2011), at 41, https://wedocs.unep.org/bitstream/handle/20.500.11822/11592/AUSTRALIA_Hg_inventory_FINAL_REVISED_April_2011.pdf?sequence=1&isAllowed=y.

[55] NEM Historical Market Information Report (2015), VIC Historical Generation Tab, https://www.aemo.com.au/media/Files/Electricity/Planning/Reports/ESOO/2015/2015%20NEMHMIR%20spreadsheet.xlsx

[56] WB/IFC, at 11.

[57] Morrison 2008, at 111 and 113.

1. Ambient environmental quality in the airshed (or water basin) affected by the plant, together with approximate estimates of the contribution of the plant to total emission loads and the main pollutants of concern;

2. The impact of the plant, under existing operating conditions and under alternative scenarios for rehabilitation, on ambient air and water quality affecting neighboring populations and sensitive ecosystems;

3. The likely costs of achieving alternative emissions standards or other environmental targets for the plant as a whole or for specific aspects of its operations; and

4. Recommendations concerning a range of cost effective measures for improving the environmental performance of the plant within the framework of the rehabilitation project and any associated emissions standards or other requirements implied by the adoption of specific measures.[58]

I believe that applying these standards in any meaningful way should result in the addition of the types of air pollution control retrofits I have recommended in this report to each of the three plants.

[58] WB/IFC, at 61.

APPENDIX: CURRICULUM VITAE

RANAJIT (RON) SAHU, Ph.D., QEP, CEM (Nevada)

CONSULTANT, ENVIRONMENTAL AND ENERGY ISSUES

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EXPERIENCE SUMMARY

Dr. Sahu has over 30 years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment for a wide range of emissions sources including stationary and mobile sources; soils and groundwater remediation including landfills as remedy; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

He has over 25 years of project management experience and has successfully managed and executed numerous projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public.

He has provided consulting services to numerous private sector, public sector and public interest group clients. His major clients over the past twenty five years include various trade associations as well as individual companies such as steel mills, petroleum refineries, cement manufacturers, aerospace companies, power generation facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, and various entities in the public sector including EPA, the US Dept. of Justice, several states, various agencies such as the California DTSC, various municipalities, etc.). Dr. Sahu has performed projects in all 50 states, numerous local jurisdictions and internationally.

In addition to consulting, Dr. Sahu has taught numerous courses in several Southern California universities including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management) for the past seventeen years. In this time period he has also taught at Caltech, his alma mater (various engineering courses), at the University of Southern California (air pollution controls) and at California State University, Fullerton (transportation and air quality).

Dr. Sahu has and continues to provide expert witness services in a number of environmental areas discussed above in both state and Federal courts as well as before administrative bodies (please see Annex A).

EXPERIENCE RECORD

2000-present **Independent Consultant.** Providing a variety of private sector (industrial companies, land development companies, law firms, etc.) public sector (such as the US Department of Justice) and public interest group clients with project management, air quality consulting, waste remediation and management consulting, as well as regulatory and engineering support consulting services.

1995-2000 Parsons ES, **Associate, Senior Project Manager and Department Manager for** Air Quality/Geosciences/Hazardous Waste Groups, Pasadena. Responsible for the management of a group of approximately 24 air quality and environmental professionals, 15 geoscience, and 10 hazardous waste professionals providing full-service consulting, project management, regulatory compliance and A/E design assistance in all areas.

Parsons ES, **Manager for Air Source Testing Services**. Responsible for the management of 8 individuals in the area of air source testing and air regulatory permitting projects located in Bakersfield, California.

1992-1995 Engineering-Science, Inc. **Principal Engineer and Senior Project Manager** in the air quality department. Responsibilities included multimedia regulatory compliance and permitting (including hazardous and nuclear materials), air pollution engineering (emissions from stationary and mobile sources, control of criteria and air toxics, dispersion modeling, risk assessment, visibility analysis, odor analysis), supervisory functions and project management.

1990-1992 Engineering-Science, Inc. **Principal Engineer and Project Manager** in the air quality department. Responsibilities included permitting, tracking regulatory issues, technical analysis, and supervisory functions on numerous air, water, and hazardous waste projects. Responsibilities also include client and agency interfacing, project cost and schedule control, and reporting to internal and external upper management regarding project status.

1989-1990 Kinetics Technology International, Corp. **Development Engineer.** Involved in thermal engineering R&D and project work related to low-NOx ceramic radiant burners, fired heater NOx reduction, SCR design, and fired heater retrofitting.

1988-1989 Heat Transfer Research, Inc. **Research Engineer**. Involved in the design of fired heaters, heat exchangers, air coolers, and other non-fired equipment. Also did research in the area of heat exchanger tube vibrations.

EDUCATION

1984-1988 Ph.D., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1984 M. S., Mechanical Engineering, Caltech, Pasadena, CA.

1978-1983 B. Tech (Honors), Mechanical Engineering, Indian Institute of Technology (IIT) Kharagpur, India

TEACHING EXPERIENCE

Caltech

"Thermodynamics," Teaching Assistant, California Institute of Technology, 1983, 1987.

"Air Pollution Control," Teaching Assistant, California Institute of Technology, 1985.

"Caltech Secondary and High School Saturday Program," - taught various mathematics (algebra through calculus) and science (physics and chemistry) courses to high school students, 1983-1989.

"Heat Transfer," - taught this course in the Fall and Winter terms of 1994-1995 in the Division of Engineering and Applied Science.

“Thermodynamics and Heat Transfer,” Fall and Winter Terms of 1996-1997.

U.C. Riverside, Extension

"Toxic and Hazardous Air Contaminants," University of California Extension Program, Riverside, California. Various years since 1992.

"Prevention and Management of Accidental Air Emissions," University of California Extension Program, Riverside, California. Various years since 1992.

"Air Pollution Control Systems and Strategies," University of California Extension Program, Riverside, California, Summer 1992-93, Summer 1993-1994.

"Air Pollution Calculations," University of California Extension Program, Riverside, California, Fall 1993-94, Winter 1993-94, Fall 1994-95.

"Process Safety Management," University of California Extension Program, Riverside, California. Various years since 1992-2010.

"Process Safety Management," University of California Extension Program, Riverside, California, at SCAQMD, Spring 1993-94.

"Advanced Hazard Analysis - A Special Course for LEPCs," University of California Extension Program, Riverside, California, taught at San Diego, California, Spring 1993-1994.

"Advanced Hazardous Waste Management" University of California Extension Program, Riverside, California. 2005.

Loyola Marymount University

"Fundamentals of Air Pollution - Regulations, Controls and Engineering," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1993.

"Air Pollution Control," Loyola Marymount University, Dept. of Civil Engineering, Fall 1994.

"Environmental Risk Assessment," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1998.

"Hazardous Waste Remediation" Loyola Marymount University, Dept. of Civil Engineering. Various years since 2006.

University of Southern California

"Air Pollution Controls," University of Southern California, Dept. of Civil Engineering, Fall 1993, Fall 1994.

"Air Pollution Fundamentals," University of Southern California, Dept. of Civil Engineering, Winter 1994.

University of California, Los Angeles

"Air Pollution Fundamentals," University of California, Los Angeles, Dept. of Civil and Environmental Engineering, Spring 1994, Spring 1999, Spring 2000, Spring 2003, Spring 2006, Spring 2007, Spring 2008, Spring 2009.

International Programs

"Environmental Planning and Management," 5 week program for visiting Chinese delegation, 1994.

"Environmental Planning and Management," 1 day program for visiting Russian delegation, 1995.

"Air Pollution Planning and Management," IEP, UCR, Spring 1996.

"Environmental Issues and Air Pollution," IEP, UCR, October 1996.

PROFESSIONAL AFFILIATIONS AND HONORS

President of India Gold Medal, IIT Kharagpur, India, 1983.

Member of the Alternatives Assessment Committee of the Grand Canyon Visibility Transport Commission, established by the Clean Air Act Amendments of 1990, 1992-present.

American Society of Mechanical Engineers: Los Angeles Section Executive Committee, Heat Transfer Division, and Fuels and Combustion Technology Division, 1987-present.

Air and Waste Management Association, West Coast Section, 1989-present.

PROFESSIONAL CERTIFICATIONS

EIT, California (#XE088305), 1993.

REA I, California (#07438), 2000.

Certified Permitting Professional, South Coast AQMD (#C8320), since 1993.

QEP, Institute of Professional Environmental Practice, since 2000.

CEM, State of Nevada (#EM-1699). Expiration 10/07/2017.