REPORT ON PROCEEDINGS BEFORE

PORTFOLIO COMMITTEE NO. 2 - HEALTH

INQUIRY INTO CLEAN INDOOR AIR

CORRECTED

At Macquarie Room, Parliament House, Sydney, on Monday 16 March 2026

The Committee met at 10:00.

PRESENT

Dr Amanda Cohn (Chair)

The Hon. Susan Carter (Deputy Chair)
The Hon. Greg Donnelly
The Hon. Sarah Mitchell
The Hon. Emily Suvaal

PRESENT VIA VIDEOCONFERENCE

Ms Cate Faehrmann

CORRECTED

The CHAIR: Welcome to the second hearing of the Committee's inquiry into clean indoor air. I acknowledge the Gadigal people of the Eora nation, the traditional custodians of the lands on which we are meeting today. I pay my respects to Elders past and present, and celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of New South Wales. I also acknowledge and pay my respects to any Aboriginal and Torres Strait Islander people joining us today. My name is Amanda Cohn, and I am Chair of the Committee. I ask everyone in the room to please turn their mobile phones to silent.

Parliamentary privilege applies to witnesses appearing from New South Wales in relation to the evidence they give today. However, it does not apply to what witnesses say outside of the hearing. I urge witnesses to be careful about making comments to the media or to others after completing their evidence. For witnesses appearing from interstate, the protections with respect to the evidence they give is more limited. I urge witnesses to be careful about the comments they make during their evidence and to avoid making adverse reflections about others. In addition, the Legislative Council has adopted rules to provide procedural fairness for inquiry participants. I encourage Committee members and witnesses to be mindful of these procedures.

Adjunct Professor GEOFFREY HANMER, ARC Training Centre for Advanced Building Systems Against Airborne Infection Transmission, affirmed and examined

Professor PRIYA RAJAGOPALAN, Professor, School of Property, Construction and Project Management Royal Melbourne Institute of Technology, affirmed and examined

The CHAIR: I welcome our witnesses and thank them for making the time to give evidence today. Would you like to start by making a short opening statement?

GEOFFREY HANMER: Yes. I don't want to read my evidence again. First, I'd like to thank you all for inviting me to give evidence to this inquiry. A large percentage of government and systemic Catholic school buildings in New South Wales fail to provide adequate ventilation and nor do they keep their occupants thermally comfortable. They do not protect occupants from particulates in the outside air or sufficiently attenuate external noise. These failures undermine the effectiveness of our school buildings. Only two types of fresh air ventilation are explicitly identified and required in the National Construction Code: window, or, as it's referred to in the code, natural ventilation; and mechanical ventilation, which must conform to the Australian standard AS 1668.2. The key difference between window ventilation and mechanical ventilation is that window openings for ventilation are proportional to the room area, while mechanical ventilation is proportional to the number of occupants.

Although window ventilation may be adequate for rooms with relatively few occupants, it's inadequate for high-occupancy rooms such as classrooms, which have more than one person per three square metres, and school halls, which may have one more than one person per one square metre. Peak levels in classrooms are measured to exceed 3,000 ppm CO2 on a regular basis, far above the goal of 800 ppm set by many regulatory bodies. Under the current standard, AS 1668.2, mechanical ventilation will deliver adequate fresh air regardless of actions by the occupants and independent of the weather. It will keep occupants thermally comfortable and filter out large particles created within the space as well as those in the outside air. The system will be quiet enough not to interfere with learning or teaching—or hearings in an inquiry. So here we are, in a mechanically ventilated space, with a reading of 600 ppm. Fantastic.

The New South Wales Government's cooler schools program is an example of how ventilation and indoor air quality is relegated to second place after comfort. This $500 million program to improve thermal comfort relies on buildings continuing to comply with the NCC window ventilation rules to meet legal requirements, but the windows are not intended to be open in normal service. While cooler schools will make students and teachers more comfortable, it is a method of avoiding compliance with ventilation and filtration provisions of AS 1668.2. A cooler school classroom does not deliver adequate ventilation or filter out particulates generated in the space, which is why the NCC requires compliance with AS 1668.2. Thrive is currently carrying out research into whether mechanical ventilation delivers better results in schools located in New South Wales, where approximately 40 schools have been sealed and air-conditioned to control aircraft noise from Sydney airport. The first paper in this research will be available at the end of 2026. Thank you very much.

PRIYA RAJAGOPALAN: Thank you very much for the opportunity to appear today as a witness. I'm appearing on behalf of RMIT University and my co-researchers, which is a research team in the school. My statement is based on our hands-on experience in monitoring indoor air quality and energy efficiency in performance of buildings, particularly public buildings, so the last pre-COVID study we have conducted in NCC class 9b and 9c, which are school buildings and aged-care facilities. The focus on public buildings is important because occupants have limited opportunity to control the air quality in comparison to homes. In our research, we have also trialled practical ways of ventilation retrofit, such as supplementary ventilation systems, and we have actually conducted measurements, pre and post, really understanding how these systems work in a real school classroom.

We believe that, in addition to designing new buildings, upgrading existing buildings to optimise energy and indoor environmental quality should also be prioritised because we have to meet our decarbonisation goals. Every building we preserve is actually contributing to our carbon goals. We also focus on the vulnerable population, including school-aged children and aged-care residents. This is because, for children, chemical exposure during development stage may produce lifelong issues and some may become apparent only later in life. We are also focused on the elderly because they are susceptible to potential indoor pollutants, even at low concentrations. What we propose is that improving indoor air quality requires a staged and scalable approach, combining immediate actions with long-term system upgrades.

The first step is to establish a monitoring system through deploying sensors, particularly in high-occupied spaces. Our study is actually focused on classrooms and common areas of aged-care facilities, which are high-occupancy spaces, and transparent access to IAQ data will increase awareness, accountability and behaviour changes. We have noticed that in school classrooms particularly with teachers and also students. What we are

actually seeing is kids not really interested in STEM or science activities these days, so this will be a very good opportunity to induce those behavioural changes and get them interested in practical, hands-on experiments with air quality. I also have to reiterate that there are a lot of sensors available, but we have to really ensure that the sensors produce quality data, so there should be clear guidelines for the sensors' calibration, routine maintenance and replacement cycles.

The second stage is effective mitigation of pollution, but it is very important to have a good understanding of the sources of pollution because they could be coming from inside the rooms or coming from outside and the interventions for these two situations are completely different. For example, a high level of particulate matter inside classrooms can also be caused by using arts and craft materials and cleaning agents. For dust infiltration, busy roads or industrial areas nearby are another source of pollution. While outdoor ventilation is advisable in the form of opening windows to flush out indoor pollutants, closing of windows is required to stop outdoor pollutants. As Professor Geoff Hanmer mentioned, we also recommend that a provision of mechanical and artificial ventilation—we call it hybrid ventilation—should be part of the standards for designing new schools. Such provision will cater for adverse conditions.

What we're actually seeing is schools—because people are becoming more and more well versed with climate change and people's comfort feeling, they understand what happens during extreme hot days and extreme cold days. So schools are actually just implementing a solution like having an air conditioner or heater, but that doesn't really provide any fresh air. When doors and windows are closed, no fresh air is coming. Also the split air conditioning mostly installed in schools—the same in Victoria—is not really providing any ventilation other than cooling or heating. So there should be a provision for outdoor air ventilation through mechanical systems when we require. I'm not saying we need to completely use mechanical systems, but there should be an option for closing the door and operating mechanical ventilation. Natural ventilation is also preferred when the outside conditions are favourable in terms of weather and particulate matter. Thank you very much.

The CHAIR: I'll start with a few questions from myself, and we've got plenty of time for questions from other Committee members this morning. I'm particularly interested in the work that you've done around schools because obviously that's something that's in the direct control of the New South Wales Government, particularly our public schools. Before we get into the weeds, I might go back a step. Both of you talked about carbon dioxide levels in your statements and in your written submissions. Can we go back a step to why carbon dioxide is the most useful thing to measure? Why is that being used as a proxy for ventilation?

GEOFFREY HANMER: It's the simplest and probably the best proxy for ventilation. Humans breathe out carbon dioxide at about 32,000 parts per million, and so if there are lots of humans in a space and they're breathing out carbon dioxide, the level goes up. Depending on how much ventilation is there to dilute that, you'll get a level in the room. What we're aiming for is a level somewhere below 800 ppm, parts per million. The air outside the Parliament here would be about 415 to 420 ppm. That's a little bit above because we've got humans in the space, but if it goes too high, what that means is we've got either too many people in the room or too little ventilation. It is an excellent proxy because the sensors for CO2 are relatively cheap, and it's easy to buy a device which will give you a CO2 reading. Rather than more abstruse methods of measuring ventilation, it's very portable. "Here we go, 591 ppm in here, still excellent." That's why we're talking about ppm.

The CHAIR: You also, Professor Hanmer, in your opening statement talked about the Australian standard 1668 part 2. In your written submission you said that while the code is not best practice it is a good start. Can you talk us through the barriers in terms of why that's not already in place, for example, in all of our public schools? If that standard exists, what's the gap between that actually being implemented in practice?

GEOFFREY HANMER: The National Construction Code gives designers an option as to whether to have natural ventilation, window ventilation, in which case the only requirement is that 5 per cent of the floor area of the room which we're talking about is openable window. That's interpreted somewhat loosely. Originally the regulations were designed around a double-hung sash window, for which the regulation for light is—guess what—10 per cent of the floor area. So a double-hung sash window is the type where you slide one half of the window up, and so half of 10 per cent is 5 per cent, and that was the requirement for ventilation.

This has been the case since about 1666 in the UK and its colonies, let's say. The thing about natural ventilation and the rules that govern it is that that is purely proportional to room area. In a room where you might expect a large crush of people, it's completely unsuitable. AS 1668.2, by comparison, asks designers to consider the number of occupants in the room and provide 10 litres a second of air per person. That's the difference between the two. I think there was another question in there as well, which I may not have answered.

The CHAIR: That's all right. I'm just trying to really clarify this. The issue is that that standard is not mandatory, that designers are being given a choice to apply that or not.

GEOFFREY HANMER: There's a choice, yes. You can do either. This is a class 9B building as well, like a school, but most of the time—in fact, all of the times that I can think of—parliaments are mechanically ventilated and schools are, typically, naturally ventilated. Community halls, schools, class 9C buildings, which are aged-care facilities—naturally ventilated; offices, parliaments, large shopping centres—mechanically ventilated.

The CHAIR: Is my understanding correct that that standard through the NCC would only apply at the point where you're designing a new building?

GEOFFREY HANMER: Correct.

The CHAIR: What are—

GEOFFREY HANMER: Correct-ish. May I correct myself. If you carry out a substantial refurbishment of an existing building, then you may be required to upgrade the existing mechanical system to the current standard. The standard has evolved, so that may be a significant upgrade if the system was designed before 1986, for instance. But, generally speaking, it only applies to new buildings.

PRIYA RAJAGOPALAN: May I just add to that. Historically, schools are designed for natural ventilation. But the quality of life of people improves and expectations about comfort increase. People are expecting to be comfortable inside. There is a lot of push from parents to the school councils to have a better thermal comfort during the summer and winter time. The summer is not really a big issue in Victoria because its schools are closed. Schools are closed during the December, January, February time. Winter is the biggest issue. That's where people are forgetting that just having a split system, there is no provision for ventilation. We always talk about HVAC, but the V is missing. I think it's an inability to think about an integrated approach for heating, ventilation and air conditioning.

The CHAIR: In your opening statement you talked about some of the research you'd done in terms of opportunities for retrofitting existing buildings. In a context where these standards apply only to new builds or significant refurbishments, what are the opportunities for intervening for the many thousands of existing schools?

PRIYA RAJAGOPALAN: There are a lot of systems in place which actually—when we first started the study, this was all pre-COVID. The idea was how do you stop the polluted air due to thunderstorms, asthma, extreme climate events. How could you actually provide a good filtration system to prevent pollution? By the time we completed the data collection, COVID started, so it was all about how do you open up so that the air is ventilated. We actually trialled a small, fresh-filtered air ventilation system which can be easily installed in the roof or ceiling of the classrooms. There were a lot of experiments for that because we first realised the system was actually costing around $3,000 to $5,000 for one classroom, depending on the size of the classroom. We just relied on the manufacturers in the beginning, but later realised that it's not as simple as you think.

The filters installed were not really the high grade which we require—for example, HEPA filters. When you add a better filter, what happens is you need more fan power. There was a pressure drop in the system. But by actually changing and adjusting all the parameters we were able to reduce the pollution level and the ventilation quite significantly in the school classroom. Interestingly, as researchers, we really struggled to find schools to do the research because the teachers, in terms of work pressure, don't have much time. We had to make it really easy for them so that we are not really taking their time. Some schools were happy to install and keep those in the school, but some were actually asking us to remove it because they didn't really want it. It really depends on the schools. But there are practical ways of retrofitting in individual classrooms if we can't do a whole centralised system for the schools.

The Hon. SUSAN CARTER: Professor Hamner, I'm not technical, so I'm just trying to understand: When you were talking about the standards being set from 1666 in relation to double sash windows, was an element of those standards that a double sash window should be open from the top and from the bottom so that it is the CO2 air going out the top and the fresh air coming in? Is that what the standard is all about?

GEOFFREY HANMER: No. You can do that with a double-hung sash window.

The Hon. SUSAN CARTER: That is exactly what those windows are designed to do, isn't it? They should be open top and bottom, not just pushed up from the bottom?

GEOFFREY HANMER: Typically they're used by just pushing one sash up.

The Hon. SUSAN CARTER: But is that correct usage, because if we're thinking about a standard setting, things being used properly, design of a double sash window is down from the top to let the hot air out, and it then draws in—because air doesn't magically come in, it needs to be drawn in, and that's why a double sash window is very effective?

GEOFFREY HANMER: You're right. But in the legislation or the regulations following 1666, which was the Great Fire of London, which introduced the double-hung sash window to London, and the following regulations in 1703, there's no indication as to how the windows were meant to be used. So you're right—

The Hon. SUSAN CARTER: This is the perennial lawyer's question, that things that are obvious are generally not regulated.

GEOFFREY HANMER: The bigger thing is that most schools don't have double-hung sash windows. If you designed a school today, you'd be lucky to get one. The problem is that we allow an awning window, which opens from the top. We count the area of the entire window, despite the fact that the annulus of the awning is far less than the opening created by a double-hung sash window. There is also a provision in the NCC—

The Hon. SUSAN CARTER: Is that change because of safety considerations that we don't want a large opening because it's not safe for children who can fall out a window?

GEOFFREY HANMER: That's one reason. The second reason is that that's just the way that the NCC is interpreted by certifiers. I don't think it's been a conscious decision on anyone's part, but that's how it has worked out.

The Hon. SUSAN CARTER: Is there a need for more education for certifiers?

GEOFFREY HANMER: You'd need to change the NCC to be specific about the fact that we're talking about free area and not just the area of the operable component of the window. But if we did that, we'd also have to think about the enclosure of the window. A typical sash window, when it opens, if it opens to a legal distance, which is generally speaking 125—the walls on the outside of the window also have an effect on the window's free area. So it's not quite as simple as that. This is one of the reasons why we measure such high levels in classrooms, because the windows, even if they're fully open, do not perform as you would like them to do.

The Hon. SUSAN CARTER: In your evidence and in your opening statement you talked about two forms of ventilation being recognised and implied that there might be more that should be considered. Are there more than just the two that you've outlined?

GEOFFREY HANMER: You can have a performance solution under the NCC.

The Hon. SUSAN CARTER: What does that look like?

GEOFFREY HANMER: Anything you like, as long as it conforms with the performance requirements.

The Hon. SUSAN CARTER: What would be an example of one?

GEOFFREY HANMER: This would be a hybrid system.

The Hon. SUSAN CARTER: Sorry, what's a hybrid system?

GEOFFREY HANMER: A mix of mechanical and natural ventilation.

The Hon. SUSAN CARTER: How is that different to sometimes opening the window and sometimes turning the air conditioner on?

GEOFFREY HANMER: It's different because it's a regulated system. It would have to produce the levels that are specified within the BCA or NCC.

The Hon. SUSAN CARTER: I'm not technical. Can you give me an example? If I walk into a classroom, what would that sort of hybrid system look like?

GEOFFREY HANMER: Hopefully it wouldn't look like anything at all, so that the people in the classroom, the teachers, wouldn't have to make any decisions about this. This is part of the problem. I think Priya has referenced this. Teachers have got enough on their plate without having to work through options for ventilation. Really, the system that's there should operate independently of whether somebody has opened the window, switched on a hybrid system, pushed a button to do this or that, because we know that in those situations, often people forget, don't have time, don't do what they need to do. Hopefully, a hybrid system looks like nothing. It just produces readings like the one on my device in this room: 615.

The Hon. SUSAN CARTER: Can you give me an example of where we could see a hybrid system in operation?

GEOFFREY HANMER: In a school?

The Hon. SUSAN CARTER: Anywhere. I just don't understand what you're talking about. I'd like to understand what you're talking about.

GEOFFREY HANMER: Okay. Well, the second floor of the law building at the University of New South Wales is a hybrid ventilation system. But I'd be happy to provide the Committee with some examples. Council House in Melbourne is a hybrid ventilation system. There's quite a few around.

PRIYA RAJAGOPALAN: Maybe I can just add that we have a good, very well operating hybrid system in the RMIT city campus. Basically, it requires some kind of an automatic window opener, so when the carbon dioxide level is really high—and it also senses the outside weather condition, not too hot, not too cold—the windows will open automatically and then let the fresh air come in. That's just one example of a hybrid system.

The Hon. SUSAN CARTER: What's the cost of that compared to other systems?

GEOFFREY HANMER: About double.

The Hon. SUSAN CARTER: What's the operating cost of that compared to other systems?

GEOFFREY HANMER: It's about the same. It's double for the simple reason that you're providing a mechanical system and you're also providing a natural system, and you're equipping the natural system with actuators. I have to say, in my experience, the first thing the actuator does is fail.

The Hon. SUSAN CARTER: That was going to be my next question. Yes, exactly. They're based on a solenoid or something?

GEOFFREY HANMER: It varies. Sometimes they're stepper motors. Sometimes they're hydraulic systems. Sometimes they're something else entirely. Rarely a solenoid, because you need to accurately move the window quite slowly. A solenoid would probably just break it.

The Hon. SUSAN CARTER: In terms of maintenance of a hybrid system, would we expect the average school maintenance officer to be able to service that type of system effectively?

GEOFFREY HANMER: Not really, no.

The Hon. SUSAN CARTER: So there'd need to be a particular service contract as well?

GEOFFREY HANMER: Yes. Any mechanical system will require service. The simpler the system is, the less service it requires. The thing about the 1668.2 compliance is the building industry is used to 1668.2, and there's people who make it their business to maintain these systems.

The Hon. SUSAN CARTER: Professor Rajagopalan, you said that your research looked at schools and aged-care facilities. Did you notice any differences in air quality in those, in internal pollutants as opposed to external pollutants, in relation to both of those settings?

PRIYA RAJAGOPALAN: I think that's a good question. We try to measure carbon dioxide and particulate matter as well as some gases. As with the earlier discussion, the carbon dioxide measurement is more accurate, whereas gases, the small research funding we normally get doesn't really have enough money to buy those sensors. But we found particulate matter was high in some of the schools. That is also depending on a lot of outside conditions, for example, activities happening, somebody is doing gardening, somebody is cutting the lawn. But there were some differences depending on if they are close to a heavy-traffic road.

We didn't really have any regional schools where we could actually measure any wood-heater smoke, things like that. But the gases, we wouldn't say we are confident with the gas measurement, but the aged-care centres were interestingly not as bad, maybe because it's all mechanically ventilated. The only time where we found a high concentration level of carbon dioxide was when there were activities—there were like 30 to 50 people gathered in a common room. But generally, normal occupancy, it was all okay. I think the peak occupancy is a problem in mechanically ventilated rooms.

The Hon. SUSAN CARTER: In the aged-care facilities, did you look at their protocols for cleaning the filters, cleaning the big metal duct work, those types of things? Sorry for my lack of precise language.

PRIYA RAJAGOPALAN: We didn't, actually. The systems we have implemented were working independent of their existing mechanical system because we didn't really want to touch. But we didn't really look at their cleaning practices.

The Hon. SUSAN CARTER: So you put in new—

PRIYA RAJAGOPALAN: Yes.

The Hon. SUSAN CARTER: If any of this was to be a long-term solution, wouldn't cleaning practices really impact the effectiveness? Also, we've had recent examples in New South Wales where, arguably, cleaning practices in mechanical ventilation have actually created problems, especially where you have people who are

immunocompromised in any way. How important are those cleaning protocols? Have you done any work looking at supervision of those and ensuring that they are carried out?

PRIYA RAJAGOPALAN: No, but we have actually noticed some of the school classrooms had really high PM2. levels early in the morning.

The Hon. SUSAN CARTER: Sorry, what is PM?

PRIYA RAJAGOPALAN: The particulate matter, which is fine particles. So fine particles and large particles—finer particles can be more dangerous to lungs, but anything under 2.5 micrometres is difficult. You need to have really highly accurate sensors to measure that. But we have noticed early in the morning, some of the schools have really high pollutant levels. When we went back and checked with the teachers, we realised that's when the cleaners come in. We haven't really looked in detail about what products they're using, but that's a really an important point for us to think about.

The Hon. SUSAN CARTER: I understand that what you're essentially suggesting is we should be looking at having the sort of sensor that you've got in front of you, Professor Hanmer, and then teachers or somebody else would have responsibility for monitoring those. Have you looked at assumption of a duty of care in terms of legal risk if they were in every classroom and it becomes a teacher's responsibility? Have you looked at assumption of legal risk in terms of duty of care and then breach if a busy teacher is unable to monitor that sensor and then appropriately interact with their class?

GEOFFREY HANMER: I'm not actually saying that. I'm saying that these are useful tools. I certainly wouldn't want to load it up on the teacher. If legal responsibility were to be at question, then I would think it would be more the Department of Education, not the individual teacher. But my ideal would be something that nobody has to look at a system but where the system just operates, and we don't have to have this sort of sensor because we're confident the system is operating correctly. It would tell us, for instance, if there was a departure from the norm. A red light would go on or something else would happen to inform people that there was a fault.

The Hon. SUSAN CARTER: And that would be part of the mechanical system that you're talking about.

GEOFFREY HANMER: Correct.

The Hon. SUSAN CARTER: You indicated there was an example of that at level 2 in the RMIT building. Is that right?

GEOFFREY HANMER: No, the UNSW law building. That's a hybrid ventilation system.

The Hon. SUSAN CARTER: From my understanding, the UNSW law building is about 10 storeys high?

GEOFFREY HANMER: Four storeys high.

The Hon. SUSAN CARTER: Why isn't it in levels 1, 3 and 4?

GEOFFREY HANMER: Because there's not a big foyer on any of those levels.

The Hon. SUSAN CARTER: So this is only appropriate for when there are foyers?

GEOFFREY HANMER: Not at all, no. It's just that that's a hybrid system. I believe the actuators are stuck at the moment, so it's not operating as a hybrid system, but it should be. These systems are very interesting and there's been a lot of work on them over recent years, but the major problem is their cost. Like I said, it's about double the cost of either a natural system or a mechanical system because you effectively end up with two systems side by side. For the amount of energy it saves, if any, I don't think that's worth it.

The Hon. GREG DONNELLY: Thank you both for coming along and thank you for your submissions. What's been exercising my mind is that so many of the buildings are already built and so many classrooms are already functioning as classrooms. Who could predict the timetable, if it ever could be written down, about the way in which existing infrastructure could be brought up to the types of ideal standards that we're looking at here? I think it's a slightly different situation with respect to looking ahead in terms of setting of standards and the possible powers of a government to legislate and regulate in regards to that are not without complications between the Commonwealth and the State.

But I'm wondering—and I'm not putting forward this in any way, shape or form as a quick fix, because it's clearly not. If you take the number of Catholic systemic schools, public schools and independent schools in New South Wales and ask yourself the question is there anything that can be essentially immediately—and I don't literally mean tomorrow or the next day. In terms of the creation of guidelines or standards, maybe even regulation

and legislation at one end of things, which is obviously at a higher level, which would in effect place an obligation on the operators of the schools to set as a priority to do what can be done with respect to their existing structures, their existing constructions, the windows that they have—to actually improve air quality as it currently is? In other words, are there things that can be done, not as a fix or even a stopgap but as a way to improve, and something that could be, from the top down in the school, subject to it realistically being able to be applied, actually applied to lift the quality of ventilation in schools as they currently are?

PRIYA RAJAGOPALAN: I am not very familiar with New South Wales schools, but every school will be different, I would think.

The Hon. GREG DONNELLY: Yes, that's a challenge, isn't it?

PRIYA RAJAGOPALAN: And, as I said earlier, the pollutants may be coming from inside or outside, so basically you first need to understand what are the characteristics of the pollutants. The solution may be different for different schools, I would think.

The Hon. GREG DONNELLY: It could even vary over the course of a day. In other words, it might start off, AM, being reasonable and, PM, there's some, dare I say, bushfire blowing smoke and particulate matter over, and that whole plan to keep that classroom better ventilated over the course of the day is turned on its head.

GEOFFREY HANMER: Perhaps in a slightly tangential way I can answer your question. At the start of COVID, the Department of Education initiated a program to make sure that schools were ventilated as well as they could be. The first thing they did was go around and survey schools, but they basically did that from a desktop. The first thing would be, if you've got a naturally ventilated school, let's make sure the windows are open and that people know that they should be open to provide ventilation, because a lot of people don't understand that. If they stand under a cool or a warm split-system air-conditioner outlet, they think that that's providing fresh air, but it's not. The temptation in winter, particularly in the colder areas of New South Wales, is for everyone to shut the windows and keep warm. The education department's initiative tended to founder in the winter following the summer in which it was launched, because people were shutting their windows to keep warm. They then said, "Well, maybe you could open the windows just a crack." Of course that's fine advice, but it won't provide the level of ventilation necessary.

This is the problem with ventilation. Ventilation and thermal comfort go together. You can't have ventilation without thermal comfort, and people respond much more quickly to thermal comfort than they do to any signs of ventilation problems. You're asking the right question. It would be good if the education department would encourage people to open the windows as much as possible, but we know in the end that that won't fix the problem, because even with people opening the windows, we've measured classrooms where the levels are way above what we'd regard as being desirable. So, no—it's a good start. I'm not criticising the idea. It's just that it will all end—as soon as it gets too cold or too hot, people shut the windows, no ventilation, that's that.

The Hon. GREG DONNELLY: Can I just follow this up and then I'll share the questions with my other colleagues? It just crossed my mind, and it might be naive and silly, but if tomorrow we woke up and there was a new requirement in New South Wales schools that the door into the room must not be closed, it must be left open, is it naive to think that that simple act—putting aside issues of outside noise coming through what is the doorframe and entry into the classroom—would not that act improve, prima facie, air quality, at least in regard to reducing CO2 in classrooms?

GEOFFREY HANMER: The research shows that that is likely to be the case, yes.

The Hon. GREG DONNELLY: This is what I was sort of flirting with in my head: Are there things that could be practically done, subject to getting everyone on the same page and agreeing, blah, blah, blah? That, in and of itself, as we know, is a challenge. But it's examples like that that I would have thought, given the cost reality of what would be needed to get us to the point of doing what we'd ideally like to do—and I take it as read for the purpose of the discussion that you're bringing the very best information to us, and we're grateful for that. In the meantime, are there some things that we should be mandating—or discussing and possibly moving to mandating and then requiring that we do—which will almost straightaway improve the quality of air inside classrooms?

PRIYA RAJAGOPALAN: The door opening may not work in many situations, particularly if it is next to—the noise and dust is a real problem in classrooms, so it's not really going to—the issue in Victoria we found during the COVID time, the advice given was all schools should open up windows, but there were many schools in industrial zones, really in the low socio-economic area, who were unable to, and they were completely panicking.

The CHAIR: Can I jump in with a follow-up question to yours, Mr Donnelly, because I think we're going down the pathway of cost, and many of Mrs Carter's earlier questions were specifically about hybrid systems. Professor Hanmer, in your written submission you talked about mechanical HVAC systems that require no attention from anyone to operate and you mentioned the Victorian experience in terms of cost-effectiveness. Could you talk about that evidence from Victoria?

GEOFFREY HANMER: HVAC systems are effective. I'm just trying to process all of the information here. Could I just go back one step and finish off with an answer to your question. This week is NAPLAN tests. You're probably not going to have a NAPLAN test with the door open. There are many reasons why the door is there in the first place. The door does serve a function and mainly that's to keep—

The Hon. EMILY SUVAAL: To keep the children in!

GEOFFREY HANMER: Yes, keep the kids in and the noisy class on the other side of the corridor out. I suppose what you're saying is if we cross-ventilate classrooms, do we get a better result? The answer is, yes, indeed we do. In fact, that used to be the basis of classroom design right up until about the Second World War, when we lost interest in such things—for a number of reasons. Back to your question, which part of my evidence are you referring to?

The CHAIR: That's on page 5. I'm happy to quote it to jog your memory. You've written:

> Improving ventilation by using mechanical HVAC systems will require budget expenditure, but preliminary work shows that this expenditure will be returned to the community in several ways, principally by a reduction in absences caused by caring for sick children.

You go on to say at the end, "if the Victorian experience is a guide". I'm interested in specifically what those Victorian findings were.

GEOFFREY HANMER: The thing in Victoria was that the Government doesn't—well, none of the State governments publish sickness absence data for teachers that I can find. In Victoria there was a freedom of information request made to obtain sickness absence data. Sickness absences were up a huge amount in Victoria post 2019. I did a simple calculation which showed that if you were able to go back to a situation which was closer to the 2019 situation, you would in fact pay for the cost of installation of mechanical systems by just saving the money on those teachers. This is not my area, believe me, but we've recently done some much more sophisticated work which shows benefit-cost ratios starting at about five and going up from there in terms of providing decent ventilation, irrespective of how you get there.

But it's clear that if we can stop both teachers and children going on sickness absences, then we'd be significantly ahead. Of course, if a child is absent it generally means the parent is home from work looking after the child, and that is also a cost to the economy. In the work that we're doing right at the moment on this, it does appear that it would be cost effective to provide full mechanical ventilation to schools on the basis of savings. The trouble is, of course, in terms of government, the savings don't accrue at the same place where they're made. The savings would accrue to companies, partly to the education department and also partly to the health system, but all of the money would be spent by the departments of education or other schools.

The CHAIR: I appreciate you might want to take this on notice, because I'm asking the architect the economic analysis questions. I appreciate some of your colleagues might have that expertise. I'm really interested in any evidence that exists or calculations that have been done in terms of the cost effectiveness, on notice.

GEOFFREY HANMER: There's a paper which is in review right at the moment. It should be ready in a couple of weeks. I'm happy to send a preprint of the paper to the Committee for them to review.

The CHAIR: Terrific.

GEOFFREY HANMER: It's much more sophisticated than my analysis.

The Hon. SARAH MITCHELL: Thank you both for your evidence. A lot of my questions have been answered. I don't know if this is a simple one, but are there any jurisdictions that you know of—maybe even internationally—that do this well or better than we do here in either New South Wales or Victoria, where most of your work has been? Do you have any standouts?

GEOFFREY HANMER: Fribourg in Switzerland, the canton of Fribourg. They have started to encourage all of their schools to adopt mechanical ventilation simply because they have tried other methods and none of them have worked. So I would say that that's the standout. I went to Germany last year to have a look at what they're doing. They're not doing much. They have a Federal standard which says that they can't exceed 1,500 ppm in a classroom, but it's mainly observed in the breach, so they don't actually enforce that regulation.

I was told by people in Germany that Denmark is doing some pretty fantastic things, but I didn't get to Denmark, so I don't know, I can't tell you.

PRIYA RAJAGOPALAN: I read there is a Boston school program where, in a particular area of the schools, air quality is actually monitored in real time and is available publicly to anyone to go and access. That, I thought, was a very good step. They probably haven't gone to the intervention or the mechanical ventilation stage yet, but that monitoring was really making the data transparent for anyone to look at.

The Hon. EMILY SUVAAL: Thank you both for your evidence so far. I just wanted to ask whether the research you've covered has looked at different school settings—like Department of Education, State-run schools versus independent schools, or whether it's just been schools in general?

PRIYA RAJAGOPALAN: Of the five schools we studied in Victoria, there were three primary schools, State-owned; one secondary school; and the fifth one was actually a Catholic school. We didn't really see much difference. Some of the private schools look new in terms of appearance, but the quality of air was not much different. The secondary school, we found, was actually not bad because of the way students keep moving in and out of classrooms. There are always doors closed and opened every one hour, so that was an example of an intermittent ventilation which is happening forcefully. But primary school kids, that's where they're all inside the classroom for two or three hours until lunch time, and that's when it really peaks because there is no opportunity to open the doors or windows for them.

The Hon. EMILY SUVAAL: In your research, going back to the point my colleague made earlier, were there any interventions that schools were putting in place or you just observed them as they were?

PRIYA RAJAGOPALAN: It was interesting. It all depends on how sensitive the teachers were to air quality. There were teachers who were very knowledgeable and they could feel the fresh air, so they made sure the windows were always open, at least for some times of the day. We continued our studies post-COVID and, if you remember, during COVID all the Victorian schools were given portable HEPA filters. At some schools, some teachers are still operating them, but many of the teachers are not really operating any of those—it's all just sitting in the corner without being even connected to power, I would say.

The Hon. EMILY SUVAAL: So they've got a HEPA filter there, but they're just not using it?

PRIYA RAJAGOPALAN: No.

The Hon. EMILY SUVAAL: But that would surely be a good step—

PRIYA RAJAGOPALAN: That won't improve the ventilation, but at least it will probably the reduce infection, yes.

The Hon. EMILY SUVAAL: I'm interested in this concept of ventilation and how we can improve it. It sounds from your evidence this morning and certainly from your submissions that the best or most effective—and perhaps cost effective as well—method that we could suggest would be through HVAC systems like what is operating in the building that we are in here. Is that what you've come to suggest or am I reading this wrong?

GEOFFREY HANMER: I'm suggesting that. I think Priya is a little bit more flexible than I. But I think my conclusion, after looking at this for five years, is that a 1668.2 system, which everyone understands—we've got engineers who can design them, we've got mechanical contractors that can build them—is a system that nobody has to intervene with.

The Hon. EMILY SUVAAL: Set and forget.

GEOFFREY HANMER: That's the best. It's not a perfect standard but it's a really good start, as we can see from here. If I had the choice between doing nothing and doing something, I would try to encourage everyone in building a new school, for instance, to make sure it had an HVAC system complying with 1668.2.

The Hon. EMILY SUVAAL: Have you done any work to quantify what that cost would be if it were to be—

GEOFFREY HANMER: I did. I wrote an article in *The Conversation* which is now a couple of years old, and I said that it will cost $10 billion to upgrade every school in Australia, but that would be spread out over five years or so.

The Hon. EMILY SUVAAL: That's Australia wide?

GEOFFREY HANMER: Yes, so $2.6 billion in New South Wales.

The Hon. EMILY SUVAAL: That's $2.6 billion.

GEOFFREY HANMER: Roughly.

The Hon. EMILY SUVAAL: Is that all schools or just the Department of Education schools?

GEOFFREY HANMER: No, that's all schools. The upgrading process is a matter for debate. Exactly how you do it would depend on the school, but certainly the Department of Education would have information on this—because remember we have 40 sealed and air-conditioned schools in New South Wales, air-conditioned to 1668.2. I think if we looked at the cost of that, which we should know what that is, then that would give us an idea of how much upgrading existing stock would be. But the cost difference between having a window-ventilated school—this is a new school—and an air-conditioned school is not that great because, for a start, you don't have to have openable windows. Openable windows themselves cost money to provide. Plus the school can be a more efficient shape, so it can be, if I can be crude about this, fatter. A fatter school means less perimeter and less perimeter means less cost. It's not just a case of adding in the system. But when we do look at the cost of that, which you'll see in this paper which will be out very shortly, it still turns out to be a very positive benefit-cost.

The Hon. EMILY SUVAAL: Can I just clarify—is that paper that you're referencing the one you also talk about in your submission? You say that Thrive is currently carrying out research about those 40 schools that have been sealed—

GEOFFREY HANMER: No, that's a separate paper. We have this perfect experiment in Sydney. We've got 40 sealed schools within the flight paths of Sydney airport, and right next to them we've got lots of schools which are naturally ventilated. The question is comparing the two and seeing what the results are. So we've started that process but we certainly haven't finished it.

The Hon. EMILY SUVAAL: And that paper will be available closer towards the end of this year?

GEOFFREY HANMER: Crossed fingers, yes.

The Hon. SUSAN CARTER: Just quickly, did the maths that you did for retrofitting include the cost of upgrading schools to three-phase power? Because I understand that's an issue with installing air conditioning in schools.

GEOFFREY HANMER: No. Most of the split systems that are there are all two-phase split systems.

The Hon. SUSAN CARTER: But I thought we were talking HVAC, not split system.

GEOFFREY HANMER: There's no difference. You can get a two-phase chiller—

The Hon. SUSAN CARTER: Sorry, the maths that you did, the 2.5 billion for New South Wales—that was on HVAC or that was on split system?

GEOFFREY HANMER: HVAC.

The Hon. SUSAN CARTER: And HVAC requires three-phase power. Did you count the cost—

GEOFFREY HANMER: No, it doesn't.

The Hon. SUSAN CARTER: We've always been told at schools that you had to upgrade to three-phase power before you could do HVAC.

GEOFFREY HANMER: No.

The Hon. SUSAN CARTER: Split system, two phase; HVAC, three phase.

GEOFFREY HANMER: Can I just explain it this way. A split system can be part of an HVAC system, and you get a two-phase—

The Hon. SUSAN CARTER: But I thought your colleague was saying that split system wasn't as good a ventilation as the V in the HVAC?

GEOFFREY HANMER: It has no ventilation.

The Hon. SUSAN CARTER: So it's not a ventilation system then. It's just an air conditioner.

GEOFFREY HANMER: May I finish? The thing here is that you can just have a fan and a duct and you can blow fresh air into a space which is then cooled and heated by split systems. That's an HVAC system. None of that needs to be three phase.

The Hon. SUSAN CARTER: Where's the ventilation coming from if the windows are shut?

GEOFFREY HANMER: The fan with the duct blowing fresh air into the space.

The Hon. SUSAN CARTER: And there's a filter on the duct.

GEOFFREY HANMER: That's correct.

The Hon. SUSAN CARTER: That has to be changed how often?

GEOFFREY HANMER: Depends on how big the filter is.

The Hon. SUSAN CARTER: And the duct has to be cleaned how often?

GEOFFREY HANMER: If the filter is on the outside, the fresh air duct has to be cleaned very infrequently because the air in it is clean.

The Hon. SUSAN CARTER: Unless there's outside particulate that your colleague was mentioning can be a major pollutant.

GEOFFREY HANMER: That clogs up the filter. Yes, you have to replace the filter, but if you don't catch it on the filter then it's going to go into all the kid's lungs. If you've got a filter which goes dirty after six weeks, then that's good value because it means you've got six weeks worth of crud which isn't going into their lungs.

The CHAIR: Sorry, I think Ms Suvaal was busting to get one more question in.

The Hon. EMILY SUVAAL: I'm happy to put it on notice.

GEOFFREY HANMER: There's certainly concern that you'll run out of power at schools. That may or may not be a problem depending on the school because they all have different power arrangements. But may I suggest that the simplest thing for schools is that they are equipped with PV installations, which many of them are now. Of course, PV installations are great during the day, which is exactly when school's in session. So PV and schools go together very well, and I think a lot of the concerns about power use and power capacity would be solved. In fact, the education department says that one of their major innovations is to put PV on to cover the power demands of cooler schools, which is a sort of half-baked HVAC system. It just doesn't comply with AS 1668.2, mainly because it doesn't filter the air which is blown into the school. That is quite a major failing.

The CHAIR: We are out of time for this session. I anticipate that Committee members will have additional questions. The secretariat will be in touch with you about those and the questions that were taken on notice today. Thank you both again for taking the time to share your expertise with us this morning.

(The witnesses withdrew.)

(Short adjournment)

Mr JACK NOONAN, Head of Asia Pacific, Senior Vice-President of the International WELL Building Institute, sworn and examined

Mr SHAY SINGH, Green Building Council of Australia, affirmed and examined

Ms DAVINA ROONEY, Green Building Council of Australia, affirmed and examined

The CHAIR: Thank you for making time to give evidence today. Would you like to start by making a short opening statement?

JACK NOONAN: Good morning, members of the Committee. It's an honour to be here. I'm a long-time member of the International Society for Indoor Air Quality, where I've held a number of committee positions, and I'm also the head of Asia-Pacific and senior vice-president for the International WELL Building Institute, or IWBI, the global authority for advancing healthy buildings, organisations and communities. Currently, WELL is engaged in more than half a billion square metres of real estate globally, encompassing nearly 100,000 assets in 137 different countries. Put another way, it represents more than eight times the total office space in New York City alone. Here in Australia, nearly 13 million square metres are engaged in WELL, equivalent to about 650 MCGs. As Australians, we spend approximately 72 years of our lives indoors, compared to less than five years of our lives outdoors.

IWBI's work is critical, as the evidence-based strategies that form the basis of the WELL standard impact hundreds of thousands of employees working for these organisations, having a direct impact on their health, wellbeing, performance and productivity. Last year, we launched the second edition of the seminal report *Investing in Health Pays Back*—I've provided copies to each of you today—which summarised the links between healthy building strategies and economic benefits from over 250 independent research studies globally, some of the best being from right here in Australia. As the global authority on healthy buildings, IWBI's recommendations are as follows. We ask that the New South Wales Government adopt the WELL standard's air-quality thresholds as the recognised best practice point of reference.

These thresholds focus on reducing fine particulate matter; carbon monoxide; nitrogen dioxide; ozone; volatile organic compounds, including aldehydes; and carbon dioxide. These thresholds have been referenced across industry and across academia globally. While they are influenced by design and operations, they are ultimately performance based. Secondly, voluntary rating tools focused on indoor air quality already exist. They are being widely used across industry and across different sectors, and they are backed by evidence, implementable, recognisable and performance based. WELL's adoption across more than 600 buildings in Australia is evidence of this. Government could and should be out ahead of this, advancing the ceiling of these standards.

To lead by example, the New South Wales Government should require that all new public buildings, including schools, hospitals and government offices, as well as any major retrofits, target at a minimum the IAQ thresholds outlined in the WELL Air concept, which is publicly accessible and based on evidence and international expertise. For existing buildings, we would recommend that buildings monitor their IAQ performance to understand where they sit related to best practice. As the saying goes, you can't manage what you don't measure. Governments globally are active in this space. Government entities in Australia, such as WorkSafe Victoria, the Victorian Health Building Authority, the City of Melbourne, Queensland Ballet, Footscray Public Hospital and the new Adelaide Women and Children's Hospital have all either achieved or are committed to not just meeting the IAQ requirements from the standard but are also formally targeting full WELL certification, which includes a third-party independent review process.

We know from these projects and those from the private sector that the infrastructure for implementation, monitoring, testing and verification is active and proven within the market. They provide a ready-made blueprint, proving that the technology, supply chains and testing expertise required to achieve healthy indoor air already exists within New South Wales. In mandating IAQ thresholds for new buildings and committing to monitoring across all buildings, the Government can ensure that the public sector workers, students and the wider community can benefit from the improved indoor air quality that is currently available in parts of the private commercial sector. I look forward to your questions.

DAVINA ROONEY: Thank you to the Chair and the Committee for the opportunity to appear here as a witness on behalf of the Green Building Council of Australia. Our purpose is to partner with industry to drive the sustainable transformation of the built environment, and that means working with over 650 member organisations, such as developers, property professionals, banks, superannuation, schools, product manufacturers, retailers, utilities as well as all the way across the Federal and State governments. We also run Green Star, which is Australia's largest holistic sustainable rating system, and work closely with our colleagues, like the International

WELL Building Institute. You've heard from many health experts previously on why we need to spend time working in air quality. One of the things that this part of the session and the inquiry brings is how we can work with buildings for practical standards to make things better.

Green Star is used as a holistic sustainability rating in design, operation, and we have a big focus on indoor air quality, specifically having credits aimed at design, construction, operating buildings in a Clean Air credit. You've heard from my colleague Jack Noonan about how that works. To be clear, we work collaboratively together and with our partners at NABERS, who also put a submission in to this inquiry. Despite the voluntary uptake of some of these frameworks, Australia does not have a national indoor air-quality standard or consistent way of measuring this. This makes it hard to understand how well our buildings are performing, and noting that we're often seeing a lot of leadership in the commercial sector, there's an absence sometimes in the areas that impact the most vulnerable, as you've heard in other parts of the inquiry.

It also reduces the ability for government to apply policy or indeed regulation in some of these spaces. The Green Building Council of Australia supports the Safer Air Project's recommendations that we should prioritise the indoor air quality performance standards in education, health care, disability, aged care, residential and workplaces. Everyone should have the right to assume that they're entering and spending time in spaces that are safe for health. Developing clear frameworks that put indoor air quality and systems to monitor those and harmonise those, New South Wales has a clear opportunity to harness the expertise of the scientific community, and it should be acknowledged that the NABERS framework has been done in leadership by the New South Wales Government, so there's an excellent opportunity to build from here.

Additionally, Green Building Council notes that clean air starts with climate action. The same fossil fuels that we're targeting within net zero strategies are the same elements that pollute the air inside our home, school and workplaces, so this is a genuine opportunity to bring together decarbonising the built environment and how we actually look at the overall environmental agenda. Another close area to be considered together is resilience for buildings and the built environment. With the horror bushfires of 2019-20, we saw air-quality issues come directly into our built environment, and there's a real opportunity to advocate for the National Construction Code, which is a Federal mechanism to ensure Australia's homes and buildings are well designed for climate resilience. Although that's a Federal role, New South Wales has a unique seat to work federally, cooperatively in this area to drive forward.

What is the ask in this? That we have agreed thresholds for what's acceptable in terms of indoor air quality by building or category; to develop measurement standards for indoor air quality that are consistent and can be taken regularly and affordably, drawing on some of the expertise that myself and my colleagues bring from today and in our submissions; incorporate air quality into a widely used tool available for industry and policy; and take advantage of new technology, including low-cost sensors. There's a real opportunity to do a feasibility study for how we bring this to market in the best way and have it right sized. It should be very openly acknowledged that the New South Wales Government has shown enormous leadership with neighbours with an indoor environment quality standard. It's worth acknowledging this hasn't been updated for 10 years and there's a real opportunity to focus on the indoor air quality that that standard already has within it.

The CHAIR: Was that a joint statement?

SHAY SINGH: That was a joint statement from the GBCA.

The CHAIR: Thank you very much for your written submissions and your opening statements. You're right that it's very helpful for us to move from "Why we should be doing this" to "If we wanted to do this, how?" Your evidence is really helpful from that point of view. In the implementation of a performance-based standard, that obviously means you can make it fit for purpose and that it's not a one-size-fits-all approach for every building. In your experience working with organisations or building owners who want to undertake this work voluntarily, what are the range of tools or examples of retrofits or upgrades that have worked to achieve those kinds of standards in practice?

DAVINA ROONEY: We've seen lots of opportunities taken. At the Green Building Council of Australia, we've worked with just on 5,000 new projects and existing projects in Australia looking at how they actually implement these areas. A lot of it on the existing building side is starting where they are, completing the measurement that Jack was talking about and delivering enhancements across a range. Within a new building sector, there's a real opportunity to focus on many of these items right at the outset and absolutely embed them in design. I would note that we have experience in schools, hospitals, commercial—FIFA Women's World Cup stadiums. There's actually a wide range of areas to which these can be applied, and there are very practical solutions from carbon-dioxide and carbon-monoxide monitoring to putting in control solutions and cleaning ducts. There's a whole range of pathways that lead to better.

JACK NOONAN: I would just add to Davina's comments to say that I think there's somewhat of a misconception in industry that only new buildings or new developments can be healthy buildings and healthy developments. The reality is that any building can be a healthy building, but the first thing that you need to do is measure how that building is performing. Unfortunately, once again another misconception is that when we talk about high performance across Australia as it relates to our built environment, often we think about energy efficiency. Energy efficiency is incredibly important, but since the pandemic I think much of industry has started to shift its definition of what high performance is to start to include aspects of indoor environment quality, specifically indoor air quality.

It's really important that we continue to shift that narrative. From a voluntary perspective, the top end of the market is already moving in that direction. We have examples of sustainable finance where organisations are borrowing money that is tied to the performance of the building from both an environmental perspective and a healthy perspective. What we are lacking is anything that addresses the bottom end of the market or the mid-tier. That is where regulation and standards need to come into place.

One final example, just as a concrete example that I like to refer to—you could probably see from my MCG example that I'm from Melbourne in the State of Victoria. One of the projects that I often like to talk about is 500 Collins Street in Melbourne, which is a relatively unimpressive building. You're walking down Collins Street, you see some of the incredible new developments that are along Collins Street. You could quite easily walk past 500 Collins Street without thinking anything. This building was built around 60 years ago. Only recently have some retrofits taken place to this particular building. They found that a number of the tenants that were looking for space across this particular area of Melbourne were moving to new developments.

They do a lot of work in relation to indoor air quality and a lot of work in relation to indoor environment quality, and they said, "If all of our tenants are going to be looking at other buildings, we really want to prove that we're a healthy building as well, even though we're 60 years old." They targeted WELL certification. They actually achieved WELL platinum certification, the highest level of certification available from the International WELL Building Institute. I often use this example to remove the myth that it's only new buildings that can target these high levels of certification. If you're measuring and you understand how indoor air quality works, any building can be a healthy building.

The CHAIR: In your opening statement, Mr Noonan, you listed a whole variety of different pollutants that can impact our health. You had particulate pollution, ozone, volatile organic compounds, carbon dioxide, carbon monoxide and nitrogen compounds. Do we need to be measuring and addressing all of those things separately in every building or are there some broad principles of the way that clean air can be achieved in a variety of spaces?

JACK NOONAN: It's a great question. I think there are some fundamentals to indoor air quality that need to be addressed. Ventilation, measuring carbon dioxide, I think is a fundamental. Particulate matter, particularly PM2.5, is a fundamental. The way that the WELL Building Standard is written, you have mandatory requirements, and the examples of indoor air-quality pollutants that are mandatory requirements from the WELL Building Standard's perspective are carbon dioxide, carbon monoxide, ozone, TVOC, or toluene and formaldehyde. They would be considered, from our perspective, the fundamentals. Getting into other specific VOCs would be seen as something that would be perhaps a little bit more advanced. Also, nitrogen dioxide would be seen as something that might be a little bit more advanced or specific to that particular project type, as an example. What we've seen, as an example, is as there's more onsite gas generation, tri-generation or co-generation, organisations might want to look at nitrogen dioxide or carbon monoxide in a little bit more detail as a result of that.

DAVINA ROONEY: I think one of the things that's probably worth acknowledging is you can also use some of your procurement standards for what you're bringing into spaces to help quite a lot with formaldehyde and volatile organic compounds that often come in in your carpet or the glue lamination in timbers or furniture. This is why coupling things with the procurement of what's coming in is really fundamental as well as the measurement of what's in place. This is one of the reasons why we actually think looking at a strategy to bring these in across different areas for existing buildings, particularly in government operations, would be really advantageous.

The Hon. SARAH MITCHELL: Thank you all for being here and for your evidence and submissions as well. I want to ask, and it's probably directed to you, Mr Noonan, but I'm also happy for other panellists to make a comment, and I know we've only just got this document, so I can't confess to having read it yet, but you also called out in your submission—I think you called poor indoor air quality a silent economic burden. You were talking about the links between that, health and respiratory distress and things. Can you just talk to us in layman's

terms of what some of the research shows, and maybe it comes back to what's in this document too, about why it's a good investment for Government to make in the broader sense.

JACK NOONAN: I would say that this research is not particularly new. The links between indoor air quality and productivity and performance have existed for over 30 years. This is not something that is particularly new, but I think the pandemic has really shone a light on the opportunity that we've been missing out on. There are strong links between increasing ventilation rates and worker performance. That also includes cognitive ability within a space. We know that as CO2 rises within our built environment—I think all of us have been in a lecture theatre when it's packed.

The Hon. SARAH MITCHELL: The parliamentary Chamber?

JACK NOONAN: Particularly after lunchtime, when CO2 is at its highest, you get tired, you get fatigued. Those same principles apply within an office type of environment. We also know a lot of the seminal research has actually come from the healthcare sector, where nurses and doctors would make more errors when the indoor air quality was poor. There is a lot of research that shows a very strong link between poor indoor air quality, errors and poor cognitive ability. What we're actually starting to do is we're starting to actually be able to quantify that.

In the *Investing in Health Pays Back* report there is research from a number of economists globally and also from a number of actual case studies that are quantifying the benefits of improving indoor air quality. As a good example—and please excuse me if these numbers are not quite right—Colliers, which is a property management company in Europe, found that there was around about a $3,500 per employee per year economic benefit from raising the ventilation within that particular space. When you think about the cost of increasing ventilation or the cost of implementing some of these indoor air-quality measures, it's really a drop in the ocean when you consider the economic benefit that we can have as a result of this.

The *Investing in Health Pays Back* report is, I think, a fantastic report. It is all independent from IWBI. We are just collating the research that is out there. I want to give a special shout-out to one particular research study. I mentioned that some of the best research in that particular report comes from Australia. There was a research study that was done by the University of Melbourne, the University of Sydney, the University of Wollongong and Griffith University—so four universities coming together—that looked at the impacts of health strategies and found that not only were there significant productivity gains from office workers that were in these well-certified healthy spaces, but also people felt healthier. There were less instances of mental health conditions, less instances of musculoskeletal disorders and less instances of what we've referred to as sick building syndrome symptoms. That is this idea of itchy eyes, runny nose, sore throat that is often referred to as sick building syndrome.

The Hon. SARAH MITCHELL: Do you want to add anything, Ms Rooney or Mr Singh?

DAVINA ROONEY: Really just to support that there's an enormous amount of research from lots of pre-eminent organisations around the world. In our submission we reference Harvard's review on *Schools for Health: Foundations for Student Success*. But it's validating that very clear link between air quality and performance that we've been really following for decades. I think the thing for us to think about is how do we translate that known research into what does the change look like that we deliver, particularly for the most vulnerable within our community.

The Hon. SARAH MITCHELL: If I can just follow up on that, you mentioned this at the beginning when you said it's not that it's necessary; it's about how you do it going forward. I note in your submission, Ms Rooney, you call out prioritising implementation in four key areas of education, health, disability and workplaces. In terms of governments of the day who deal with these issues—and we've been in; you guys are in now, but these things happen—the decision to prioritise those areas, to me, seems like a commonsense approach in terms of where you've got the settings and maybe people who are more vulnerable. Is that where that sort of decision has come from, just trying to prioritise in a sensible way?

DAVINA ROONEY: Absolutely. I'll let my colleague Shay talk to this, but one of the things that we really try to do is look at how do we actually go from the why to the how and what's a simple pragmatic step. Shay spends a lot of time considering this space.

SHAY SINGH: Thank you. It's also looking at the opportunity of where you can make the most impact, so public buildings. Governments own and occupy a lot of public buildings, so for us it's a logical place to start. This is where the Government's procurement policies come into play to raise the standards and that then enables the wider market as well. That's our rationale. If you look at kids—or people in hospitals—they spend a lot of time in school. They don't actually have a choice, they can't have a say, but in fact that's their learning pathway and you want to create the space that best sets it up for them for the future.

DAVINA ROONEY: We probably should note that we're actually working with some of the government offices with New South Wales schools that are implementing some of these things up-front in their school design and part of this relates to existing New South Wales Government policies. So you do actually have a great position to start moving forward from.

The Hon. EMILY SUVAAL: Thank you so much for your submissions and the detailed opening statements as well. I just wondered, Ms Rooney, if I could start with you in terms of your reference to NABERS and the suggestion that perhaps that's something we could relook at. But I also wanted to pick up on your submission, which references:

> 6.2 Commit to applying trusted, robust and credible building rating systems such as Green Star and NABERS in all new government projects and existing assets and accommodation.

I just wanted to double-check with you, the existing NABERS framework, is that something that you think in its current form is sufficient, or do you also suggest that we relook at that? If so, what are the areas that you think could be improved?

DAVINA ROONEY: Fantastic. I guess the first thing to start talking about is do we think that government should seek pathways to implement these things in new buildings and implement voluntary rating standards. We absolutely do and seek to apply frameworks. We absolutely need to work on existing buildings, which are very complex and will take a pathway to work your way through lots of the different sectors. With the new buildings, you do actually have procurement pathways, and you already have leadership work at a national scale that you provide out of New South Wales on your net zero.

So there's a real opportunity to bring that in and for an enhancement in that particular area. What I would actually say on the NABERS side—and again I'll defer to my colleague Shay, and I think Jack might like to contribute as well—NABERS has done some excellent work. They have an indoor environment quality scale. They absolutely address indoor air quality. The standard hasn't had a detailed review for over 10 years, or since the pandemic. Some of the areas for consideration are some of the new challenges that have arisen in that time, and Shay, who sits on their committee, has spent a lot of time considering what those changes might look like.

SHAY SINGH: For the purpose, a feasibility study might be a good way to look at what are the steps required to enhance the current IEQ tools to be able to serve the purpose for IEQ as well. One of the things we look at is that it's a tool that has been well accepted and adopted. It's in Federal Government policy already and in some State Government policies, so it's well placed to drive this.

The Hon. EMILY SUVAAL: What are the deficiencies around IEQ currently? I have to confess, I'm not familiar with the framework. I'm happy to be familiarised. If the Committee was going to suggest a specific area of improvement, or recommendation, what would that be?

JACK NOONAN: I'm happy to take that. Just as a way of background, I've worked quite extensively with the NABERS indoor environment tool over my career. I worked on the largest NABERS indoor environment portfolio back when I was a consultant prior to my time at IWBI, which involved NABERS IE assessments of over 45 commercial office buildings. I'm very familiar with the tool. Davina is right, it has not had a significant update in a long time. That update—I'll be very blunt—is well overdue. A very good example of where it is deficient, in my opinion, is that currently NABERS indoor environment only looks at PM 10. So particulate matters of 10 microns or less. From this inquiry, you will probably see the term PM 2.5 come up a lot. NABERS indoor environment currently does not require any measurements around PM 2.5.

In my opinion, that is a deficiency of the tool in its current state. So a simple update, but it's something that it needs to be updated to include PM 2.5. Another important aspect of NABERS, which is a huge advantage of the tool but also needs to be considered, is that NABERS is essentially a benchmarking tool. What that means is that unlike Green Star and WELL, it is not based on an absolute threshold where it's simply a pass or fail type of system. It is relative to other buildings in the marketplace. That's one of the reasons why I think it was initially called NABERS, because it's how you compare your building to your neighbour's. For energy efficiency, that works very well because if your building is performing very well from an energy efficiency perspective you might be sitting at five star. So you're best practice. If you're average, you sit at three stars. If you're poor, you're one star.

NABERS doesn't necessarily really care what your energy efficiency performance is. It spits out a rating based on that particular performance. Why is that a problem for indoor environment quality or indoor air quality? You can, based on where the market is, theoretically, if you're using a benchmarking tool, have buildings that are assigned a particular rating that might be considered to the market as high performance but might be outside of the World Health Organization's recommendations around indoor air-quality pollutants, because it's based on a benchmark rather than thresholds. In any prospective update to NABERS Indoor Environment, my

recommendation would be to look at the contaminants that are currently included within NABERS Indoor Environment and review that in that light, but also look at the mechanism for how you can include a threshold within that benchmarking mechanism for that rating tool.

DAVINA ROONEY: I think the other opportunity is making air quality more prominent in it. It's a broad indoor environment quality that also looks at daylight and also looks at lots of other areas. As we've seen, this is an inquiry about indoor air quality, not broad indoor environment quality. There is, with everything that's been happening in the world, a heightened focus on that. Bringing that heightened focus to make it very available to anyone who's using the tool would also be another area of increased prominence on air quality in all display information that's given back to the market.

The Hon. SUSAN CARTER: Apologies, because I know this has been discussed and I'm just trying to get it straight in my head. Mr Noonan, I understand that your submission is essentially that we should be adopting the WELL standard?

JACK NOONAN: Sorry, just to correct that, using the thresholds that are publicly accessible in the WELL standard.

The Hon. SUSAN CARTER: But from your submission, Ms Rooney, I thought you were advocating for adoption of the Green Star standard. Is that the same as or different to the WELL?

DAVINA ROONEY: We actually work enormously closely. We work very closely together and we seek to harmonise limits. We have crosswalk pathways between us. The thing we're primarily advocating for here is that we adopt clear limits for different building types and then, when available at different stages in the procurement process, we use appropriate voluntary standards. In the new build setting, both Green Star and WELL are helpful for telling you not to put the wrong carpet in in the first place. NABERS measures afterwards how toxic that carpet is. Having voluntary standards available up-front for consideration is very important. We recommend a feasibility study is done to decide exactly how government would implement that.

The Hon. SUSAN CARTER: So you're recommending voluntary, not mandatory, standards?

DAVINA ROONEY: How we describe ourselves is, where voluntary standards are available in the marketplace, they can be made mandatory in government procurement.

The Hon. SUSAN CARTER: But your recommendation to us is that voluntary standards be referred to or that voluntary standards be mandated?

DAVINA ROONEY: Our recommendation would be, within government procurement, that you consider mandating standards that come from the voluntary sector to actually have enhanced procurement pathways. We also recommend that you mandate measurement of operational spaces so you can see where limits are and enhance them. We recommend you do that against known benchmarks, hence why we recommend and reference the NABERS system that already exists.

The Hon. SUSAN CARTER: And how would that operate in areas that are not subject to government procurement—so private hospitals, private schools and other buildings?

DAVINA ROONEY: There's different pathways to be considered, and so this is why we think there needs to be feasibility of stepped pathways. We actually think that putting in requirements in government operations as a leadership position, updating these standards, working their way through, continuing to gather evidence and then looking at—there's two different pathways. One is looking at New South Wales's role on the National Construction Code. The other is on New South Wales based regulation. Shay, do you have any other perspectives on our recommendations of bringing in government operations first, enhancement of standards, and then looking at how it evolves to more regulation beyond there?

SHAY SINGH: I think the benefit of the government regulations for the government asset is that it builds up the market and the capacity within the market, and it sets the benchmark that the industry understands. Therefore, when you do get to a regulatory point, and particularly directed to B, C and D grade tier assets, the know-how and the knowledge is already in the market, so it's not hard a step, and that's where the Government's leadership role is essential.

The Hon. SUSAN CARTER: So you're focusing on new building; you wouldn't, for example, be advocating for retrofitting all existing schools with HVAC?

DAVINA ROONEY: Our recommendation is that you do measurement pathways, see where they are and then do retrofits that couple with them that, in quite a number of cases, may actually lead to retrofitting of ventilation in other areas.

JACK NOONAN: Yes. I think one of my main points in the submission is that—it's a great old saying for a reason—you can't manage what you don't measure. The reality is that we don't know what the indoor air quality is across much of our built environment, particularly from a school's perspective and particularly from a healthcare perspective. We've got a pretty good inclination that it's not great, but that measurement hasn't actually been done. Going back to the NABERS example, one of the reasons why a commercial building disclosure was so effective for energy efficiency in this country is that there was no requirement of the commercial building disclosure Act to improve the energy efficiency of buildings.

All that was required was that building owners had to provide or show their NABERS certificate, their NABERS rating, when they sold or leased out their space. That drove improvement in energy efficiency, but that was not the requirement. The requirement was that you had to disclose the energy efficiency of the building. What we're advocating for is that we should be testing these spaces because, when you test these spaces, market transformation generally suggests that then organisations and individuals will start to do something about it once they recognise that their air quality is suboptimal.

The Hon. SUSAN CARTER: But would your example of NABERS apply in the same way to a school setting, unless you give parents absolute choice about what school in which to enrol their children, and in regional areas that absolute choice may not be possible?

JACK NOONAN: Yes, but I certainly don't think that just because you don't have a choice of what school to go to means that we shouldn't be testing indoor air quality with our spaces.

The Hon. SUSAN CARTER: No, that wasn't my meaning.

DAVINA ROONEY: No, I think you're right. One of the things that we note is that, without a driver to disclose or review these items, for lots of reasons, the reviews aren't undertaken. The thing that we found is it's very compelling providing people information in all parts of the asset cycle, whether they're commercially held or whether they're held within government. In the school example—the disclosure requirement in office makes you prominently display it—I actually do think it would be quite compelling for communities if you could prominently see what the air quality was like in your children's space and that was shared with the community. I actually think that you would get quite a lot of engagement from the community in that scenario of how you drive enhancement.

The Hon. SUSAN CARTER: To be accurate, though, wouldn't it need to be an air-quality measure for each classroom and each different space? Is air quality likely to be uniform throughout a school?

JACK NOONAN: It would need to be representative of the school environment.

The Hon. SUSAN CARTER: Is it accurate if it's representative? Doesn't it have to be this classroom, this hall, this COLA?

JACK NOONAN: It also depends on how you're measuring. We know that the sensors are significantly lower in cost than what they were even 10 or 15 years ago.

The Hon. SUSAN CARTER: Just to clarify, because we were talking about sensors with the earlier witnesses, are you talking about CO2 sensors or are you talking about different types of sensors?

JACK NOONAN: You could theoretically have sensors that look at both CO2 and PM2.5. Many sensors now even look at—

The Hon. SUSAN CARTER: But which ones are you advocating for to do these measurements so that there's disclosure about air quality?

JACK NOONAN: From our perspective, IWBI, we would be advocating for the measurement of CO2, PM2.5 and TVOC.

The Hon. SUSAN CARTER: How easy or difficult are those sensors to operate and read?

JACK NOONAN: They're very easy. I forgot to bring it up to the desk at the moment, but I've got a small little air-quality sensor in my laptop bag. I can see that looks like an Aranet sensor there.

The Hon. SUSAN CARTER: I have no idea what I'm looking at.

The CHAIR: Carbon dioxide, live in this room right there.

The Hon. SUSAN CARTER: Is that good or bad?

The CHAIR: It's good.

The Hon. SUSAN CARTER: Do these measure carbon monoxide?

JACK NOONAN: They can, yes.

The Hon. SUSAN CARTER: Do they regularly do that? Because that's more of an issue than carbon dioxide, isn't it, for health and safety?

The CHAIR: I don't think I'm allowed to answer your questions.

JACK NOONAN: I'm happy to try to answer. Carbon monoxide is a known contaminant that often is caused by combustion.

The Hon. SUSAN CARTER: I thought it was more than a contaminant; I thought it was a known poison.

JACK NOONAN: Yes, it is something that can be quite hazardous, particularly when you've got a combustion source within an enclosed environment.

The Hon. SUSAN CARTER: Have you done any work on legal liability? For example, if a school put in a monitor that was for CO2 but wasn't measuring for other particulates and wasn't measuring for carbon monoxide, are they likely to be exposed to legal liability if other schools are monitoring for more?

JACK NOONAN: I'm probably not qualified to answer that particular question, but I'm sure that there will be others across the inquiry that might be able to answer that question.

The Hon. SUSAN CARTER: Ms Rooney, my understanding of the Green Star system is that air quality is a credit not integral to the Green Star. Is that right?

DAVINA ROONEY: There's a whole category on "healthy", so there is quite a lot of information across the rating standard to do with—

The Hon. SUSAN CARTER: Can you get the Green Star without the air-quality credit?

DAVINA ROONEY: You can get pieces of it, but there's mandatory minimum requirements on air quality that are mandated within the rating tool.

The Hon. SUSAN CARTER: How do you get pieces of a Green Star?

DAVINA ROONEY: You actually have mandatory minimum requirements in this particular area across "healthy", and there are additional credits that you can go from within this pathway as well.

The Hon. SUSAN CARTER: What's the difference between the healthy base and the good air-quality credit?

DAVINA ROONEY: There are differences that people can go for in premium standards.

The Hon. SUSAN CARTER: But if we want good air quality, why isn't that the base level in the Green Star?

DAVINA ROONEY: We cover lots of different areas across energy, water, waste—quite a large number of areas. Twenty years ago there was only two minimum areas. We've substantially increased it into these areas.

The Hon. SUSAN CARTER: Do you look at integration between artificial air-quality generation and power consumption?

DAVINA ROONEY: Yes.

The Hon. SUSAN CARTER: Is there anything you could provide us with about power consumption and HVAC, for example?

DAVINA ROONEY: Yes. What we're starting to see is, done poorly, a lot of extra ventilation rates can use a lot of additional energy. Done well, optimum solutions can be found in quite a lot of these different pathways.

The Hon. SUSAN CARTER: I'm aware of research about very low-tech solutions, which may not be optimal, but everything contributes to the picture. Have you, for example, done any research or looked at any low-tech solutions such as increasing plants inside an environment?

DAVINA ROONEY: These are pathways that we recognise within the framework. Natural ventilation, opening windows—all of these are pathways that are recognised. They would also be recognised in the measurement of the actual pathways.

The Hon. SUSAN CARTER: But that wouldn't be part of a recommendation in a Green Star program?

DAVINA ROONEY: Plants is a recommendation. Ventilation rates and natural ventilation are all recommendations in the design part of a Green Star program and would be recognised in the validation, because you would actually see enhanced measurements that you would be measuring through those pathways. It's a similar pathway with WELL.

JACK NOONAN: Yes. Just specifically in relation to plants, we have a credit within the WELL Building Standard that looks at biophilic design and the incorporation of plants within a space. We don't look at it from the perspective of indoor air quality; we look at it from the perspective of the impact of plants on mental health outcomes. As a long-time member, as I mentioned, of the International Society of Indoor Air Quality and Climate, the research in relation to plants improving indoor air quality is quite mixed. Typically the best outcomes are when you're using plants and a soil substrate to draw air through that soil substrate. The substrate is acting as a filter. The idea that an individual pot plant is having a significant impact on indoor air quality is something that is not grounded in science.

The Hon. GREG DONNELLY: But they look good.

JACK NOONAN: They look great,. and they're great for our mental health as well.

The Hon. SUSAN CARTER: And they're good for controlling humidity too.

JACK NOONAN: Yes.

The CHAIR: Thank you very much again for the time you've taken to give evidence today. I anticipate that there will be supplementary questions from Committee members. If so, the secretariat will be in contact with you about those.

DAVINA ROONEY: Fantastic, and we're very happy to provide more detail and support. Thank you so much for the opportunity to speak with you today.

(The witnesses withdrew.)

Mr MICHAEL de WALL, Senior Vice-President, Australian Education Union, NSW Teachers Federation Branch, affirmed and examined

Mr DAMIAN PURINS, Work Health and Safety Officer, Australian Education Union, NSW Teachers Federation Branch, affirmed and examined

The CHAIR: Welcome. Thank you so much for making the time to give evidence today. I think we had originally invited you to appear at our previous hearing in the same session as the representatives of the nurses, midwives and doctors. Now that we've had quite a fulsome discussion about school settings this morning, it actually feels like better timing to have you here today. Would you like to start by making a short opening statement?

MICHAEL de WALL: Thank you, Chair and members of the Committee, for the opportunity to appear today. The Teachers Federation represents over 60,000 members across public education workplaces. For our members, clean indoor air is not a luxury; it is a pedagogical, industrial, accessibility and work health and safety matter. Safe indoor air quality is the essential foundation upon which effective teaching, learning and workplace safety are built. Currently, the majority of classrooms and learning spaces in New South Wales are compromised by a systemic reliance on outdated and often ineffective natural ventilation strategies, effectively just opening doors and windows.

In the real world, these strategies are often unworkable due to prevailing weather conditions; the location of many schools, near main roads and intersections; poor outdoor air quality, including during bushfire smoke events; or just the background noise created by common school activities such as sport, music lessons, practical PE and lawn mowing and general maintenance. Furthermore, an over-reliance on manual interventions falls short of the standard of risk management required by New South Wales work health and safety laws and codes of practice. It is hard to understand how the NSW Department of Education and TAFE NSW can hold that they have genuinely discharged their duty to eliminate or minimise the risks of harm as far as is reasonably practicable in their current approaches to indoor air quality where avoiding the cost of engineering control measures seems to be the highest priority.

What is clear, however, is that the lack of clear guidelines and enforceable standards in relation to indoor air quality, especially in relation to pollutants and carbon dioxide concentrations, assists the department, TAFE and other PCBUs to avoid taking urgent action to protect the health and wellbeing of workers. Without constant automated monitoring and clear standards, indoor air quality remains a blind spot that is often dismissed as a facilities maintenance issue rather than a core safety control issue. The scientific evidence is abundantly clear: As stated in our submission, the federation accepts the findings and recommendations of the scientists. When we fail to manage the air that our children and teachers breathe, we fail them.

The science tells us that high levels of CO2, which accumulates rapidly in crowded, poorly ventilated classrooms, is correlated with impaired cognition, poor concentration and diminished learning outcomes. The science also tells us that CO2 concentrations can act as an effective and easily measurable proxy for indoor air pollutants and airborne pathogens. Most people's lived experience tells them that crowded learning spaces are hotbeds for the spread of respiratory illness and the transmission of pathogens like COVID-19, RSV and influenza. The scientific consensus supports the lived reality of students and teachers: Poor air quality leads to illness, exacerbates asthma and other chronic conditions, and leads to higher levels of absence for staff and students. The primary barrier to action is not a lack of science or technology; it is a lack of clear and enforceable standards and a lack of leadership from successive governments and their public education agencies.

I also note that we need to acknowledge the context of this discussion. While all levels of government must take responsibility for their actions, there is a massive shortfall in Federal Government investment in schools infrastructure. The Albanese Government restored a public school capital fund for 2023-24, but it was a one-off $215 million investment nationwide. Private schools will receive $2.93 billion in capital funding from the Commonwealth Government between 2025 and 2034, according to the Department of Education estimates. There is no allocation for public schools budgeted at this time and, as such, most decisions made around infrastructure are compromised decisions.

There are a few things that the federation has recommended that I will reiterate here. We believe that clear and enforceable standards drive action. This must include enforceable air-quality standards in the work health and safety regulation or in relevant SafeWork NSW codes of practice to drive change in the area of air quality. Air-quality monitoring in learning spaces should be mandatory. We need routine transparent monitoring of key indoor air gases and pollutants, particularly CO2 and PM 2.5. Clear information allows workers to act to protect their health and safety and to properly identify hazards. Collecting data would allow public education agencies to meet their work health and safety obligations in this area.

There must be a substantial investment in public education infrastructure. The New South Wales Government must lead and fund the transitions to modern ventilation and air filtration systems that ensure that every worker and every student has access to safe indoor air. Indoor air quality must also be considered an accessibility issue. The medical consensus appears to be that around 50 per cent of the population has some form of chronic illness and, for many of these people, low indoor air quality significantly increases the risk of harm. The lack of clear guidelines and uncertainty in this area suggests that the public education agencies are not meeting their obligations under State and Federal disability legislation.

Finally, a longstanding issue, all remaining unflued gas heaters must be removed from learning spaces. The most recent public data suggests that over 50 per cent of public school classrooms still have unflued gas heaters. This is startling and indefensible. The Woolcock institute research that the NSW Department of Education relies on—and it is publicly available on the website—does not condone the use of these heaters. In fact, it says that safer options should be pursued. The federation believes that an inquiry into clean indoor air must consider the harm caused by unflued gas heaters and the relevant pollutants that they release.

In closing, just as we do not ask schools to organise their own clear water, we should not expect them to have to manage unsafe air on their own. The federation supports calls from the scientific community and campaigners for the New South Wales Government to demonstrate leadership and to mandate enforceable indoor air-quality standards. The New South Wales Work Health and Safety Regulation and the SafeWork NSW codes of practice provide ready opportunities for immediate change to make clean indoor air a reality in all public education workplaces and classrooms. We welcome your questions.

The CHAIR: Earlier on in your statement, you referred to clean indoor air as a component of a safe workplace. I'm inclined to agree with you. Obviously, there is already a significant legislative and regulatory framework around workplace health and safety. What are the particular gaps or barriers at the moment to action being taken under that framework?

MICHAEL de WALL: I believe it's to do with the enforceable standards. Damian has led our process for our submission, as our work health and safety officer, and may have more detail.

DAMIAN PURINS: I think it's the invisibility of the things that may cause harm. There's a ready understanding that breathing will produce CO2. There's a clear recognition, I suppose, that if you have open windows and doors then maybe the air inside is cleaner, but on what are we basing that judgement if you're a worker? I've worked in situations where there's been a tyre fire 200 metres from a school, and clearly there's pollutants in the air. If you open the windows, the ash and stuff is going to come in. But there can be other pollutants in the air that I can't see or smell if I open the windows. There are pollens in the air for some students. What are you making the work health and safety judgement on to reduce the hazard if you can't really clearly see the hazard? I did bring with me—there's an example to be made that clearly people can identify these hazards.

I think in the previous hearing you heard a little bit, maybe, in some of the submissions about Boston public schools. It seems outrageous to me that in 2022 a public school system could implement, in every single classroom that they manage, monitoring of CO2, carbon monoxide, PM2.5, PM10, humidity and temperature, and make it publicly accessible for everybody. I can get on there and see stuff. Any parent who's concerned can get on and see things. Workers who might have concerns about their health and safety could look at those hazards and try to do something about it. Right now it's invisible. I have an example here from Boston public schools. What I'd like to compare it to is what our Department of Education does. You understand that we have sort of two main sets of employers that we work with, the department and TAFE NSW. So it is a question about what they do, I suppose, in our work with our members.

In Boston public schools, it's transparent—clear. I downloaded from a table on Friday the several rooms where CO2 was high and where pollution was high. Anyone could have seen that, including the people who are in charge of foreseeable risk in those schools, and they could have taken some action about it. The Department of Education has chosen not to install monitoring; therefore, they cannot do the foreseeable risk thing for themselves, which is also their obligation under work health and safety. The workers, too, can't do that check for themselves in most rooms in the State. In the cleaner classrooms program, the department has demonstrated they can install these things. They can install ventilation systems that bring in outside air automatically. They can install systems that have CO2 monitoring and warnings and use those to make change.

I guess the answer to your question initially—it's the lack of information that prevents people looking after themselves. They've got a duty to look after themselves and each other, but if you haven't got the information to hand then you can't do anything about it. They're really strongly arguing that it is really a manageable cost that CO2 monitoring is installed in every classroom in the State and linked up to a public system that everyone can see. The department can do its job on foreseeable risk, and our workers can do what they need to do to look after themselves in their classrooms and look after their students. Community members can see and make their own

judgement about whether they think the rooms are clean and make decisions about wellbeing of their children that aren't just based on what they think might be the best practice without information.

The CHAIR: That's very helpful. I also wanted to ask about the broad range of solutions that are available to improve indoor air quality once it's recognised as poor. Already this morning, we've had discussions ranging from things like simple policy changes requiring doors to be open, portable HEPA filters and fans, all the way through to major HVAC upgrades or engineering solutions to the problem. Have you got a view on what sort of solutions work best in a practical way?

DAMIAN PURINS: I guess what works best are things that require the least decision-making from someone in order for something that's invisible to be looked after, so ventilation that is automatically triggered when CO2 reaches a certain level, for example, in a classroom would be a very helpful thing. That's not to say, though, that there aren't classrooms in the State where properly operating windows, doors and cross-ventilation in well-designed rooms would not be an appropriate thing to do. Technology isn't just about high-tech things or sealing up classrooms from outside. I catch the train to Central every day, and I'm watching a skyscraper go up that's got opening windows and habitat spaces that's costing billions of dollars. It isn't about sealing everything. But they'll have monitoring. They'll open them when that's appropriate and they'll close it when it's appropriate, because it's business, and business pays to make sure that people are safe. Department of Education doesn't do that in that sense, in the same way.

Yes, by all means, HEPA filters are available. Victoria, as I'm sure you know, during COVID rolled out 110,000 to their classrooms and installed them pretty much in every classroom and gave instructions about operating them. New South Wales provided the bank in areas where they thought it might be problematic, based on an audit of classroom spaces. So, yes, increased filtering would be appropriate—obviously, HEPA filters seem to very much take pathogens out of the air and slow the spread of disease, and properly functioning windows and doors would be useful—but remembering that ventilation can be compromised really easily. Ventilation comes into the facility's code of practice, but so does thermal comfort. If you go to the Department of Education website, go to School Infrastructure and it talks about thermal comfort. Thermal comfort's managed—often we're talking about sun coming in, for example—by pulling down blinds and closing windows with film on them. Once you pull down the blinds or close the window with film on it, you no longer have ventilation, so you have this sort of weighing up of thermal comfort.

The best interventions are ones where people don't have to make those compromises, don't have to make decisions about things they can't see, about pollutants or pollens in the air, that actually are engaged based on the best information available. That has to be driven by monitoring of some sort, so that people can make decisions on what is the best thing, because I think it's very hard to say what the best thing is in a particular context unless you've got the data that you need to make that decision on. That being said, it's clear that ventilation like in this building can be installed. The department installs it. They can't argue at all that they haven't got the capacity to install air-conditioning systems in schools that bring in outdoor air, triggered by CO2 monitoring, because they do, when they do the Cooler Classrooms program. They have that capacity to change the mix of air based on the readings they take in for health. Hopefully, that answers the question.

The CHAIR: I was quite alarmed, as a former GP, about the statistics about unflued gas heaters that remain. I understand that when the department was asked about that at budget estimates, they were also providing figures for removal of gas heaters. Have you got any information through your members about the process of having those removed? Are schools receptive and supported to make that change when it's brought to their attention?

DAMIAN PURINS: No. That's why they're still there, because no-one wants them. No-one's arguing in favour of unflued gas heaters. No, schools aren't supported to get rid of them. As I understand it, they get replaced if they reach end of life or need repair. So rather than replace them like for like, I think they change them, but that would be a question for the department. The Cooler Classrooms program removes the heaters, the rollout, but that's not for every school and, as I understand it, we're still not even at half of schools having the heaters removed. Or maybe the other way of looking at it, around half, or more than half, of classroom spaces still have those heaters.

The department will often point to the number of schools that have had air conditioning put in, say, in library spaces or so forth. That's partly, as I understand it, for safe spaces in bushfire or something where people can go to and have ventilated rooms that are safer. But the number of schools doesn't reflect the number of classroom spaces, so you might have one big air-conditioning unit put into a library, but all the other rooms are still unventilated or require open windows and doors so you can operate the unflued gas heaters, which is incredibly unscientific to me. There'll be a student sitting near a window a long way away from the heater and there'll be a student a metre away from the heater. I don't believe, unscientifically, that the impact is the same for

both of those students if you open both windows and doors and I don't think any real research has been done into it.

I just find it amazing that the department relies on the Woolcock institute report, which is on their website, which doesn't say what they claim it says. It doesn't defend the use of the heaters. All it says is it causes asthma in students that have asthma—it causes increased asthma in those students—and it didn't lead to reduced lung capacity in those students during the course of the research. But it also said in its limitations that they didn't use the heaters very much at this time because it was a warm winter and, in their conclusions, they advised that safer means of heating should be found, essentially. If that's the best research you've got to defend them, I struggle to understand how we are in a situation in New South Wales where government after government says, "Open the windows and doors in cold places and you'll be fine." It's bizarre to me.

MICHAEL de WALL: Also to the matter of willingness and receptiveness, if you like, around the motive to remove these, the history of the will has come from campaigning from parents and teachers in various communities, and that's over many years in different—particularly cold—communities. I used to be the organiser for the Blue Mountains and we had a number of schools up there where the parents worked actively with teachers and various bodies representing asthma to try to get those heaters removed. It's been a long time coming and there's still a lot of work to do, clearly.

The CHAIR: I think that detail is going to be very helpful when we can hopefully question the Department of Education.

The Hon. SUSAN CARTER: I haven't read the Australian Academy of Science report that you refer to in your submission. Do they have their own indoor air-quality standards that you're supporting? Are they referring to the WELL standards? What are the standards that you think we should be looking to implement?

DAMIAN PURINS: I didn't bring a copy of their report, but there are a few lines through it that I think are interesting. I might not get the title correct, but Professor Morawska seems to be or is the leading scientist in this area. I guess what she's arguing for is something that we can clearly accept: that CO2 rises rapidly—her research goes into that area partly; that children breathe quite quickly and, in a classroom situation, CO2 levels increase quite rapidly. I think there's general consensus in the community that the level of 800 parts per million is when we begin to get concerned and up around 1,200 parts per million is where cognitive decline and other issues become really evident. Right now, though, these are just recommendations. There's no standard. There's an acknowledgement, say, in the SafeWork NSW code of practice that CO2 is problematic, but that's all. It doesn't say that it should be ideally under 800 parts per million, for example.

The Hon. SUSAN CARTER: You're only looking at CO2, you're not looking at other particulates or other gases?

DAMIAN PURINS: I would say that, in reading the report, it was clear to me that the science was suggesting that monitoring of those things was appropriate. But I'm not a scientist; I'm an English teacher. They make several recommendations that I think are sound but, as I said, I haven't got the report in front of me. Basically what I'm saying is I haven't got a number. I think there's regulation available. I would rely on what the scientists are saying in that area. But I'm very interested in CO2.

The Hon. SUSAN CARTER: Unfortunately, what this Committee is seeing is that there seem to be different standards which may overlap, but I'm also not a scientist so I am looking for guidance that you can give us. There are some very strong statements in your submission in relation to SafeWork obligations. Has there been a report made to SafeWork about air quality in schools?

DAMIAN PURINS: It would need to be based on the data, which the department seems to be gathering, but they haven't reported it, as far as I'm aware.

The Hon. SUSAN CARTER: There's been no thought that teachers might gather their own data if this is a real concern and then report to SafeWork so that investigation is done in that way?

DAMIAN PURINS: It could be, but what we'd be coming up against is sort of what your first question was about: What would be the hazard, I suppose, in the absence of an enforceable number or a situation? For example, there are numbers for things like formaldehyde exposure. But for the pollutants we're talking about, PM2.5, PM10, carbon dioxide, there isn't a number. I believe that it would not be beyond the facility's code of practice to say that CO2 should be kept below 900 parts per million, for example. That's above what would be generally accepted at 800, but you could draw a line and say that once you got to that point, it wasn't acceptable anymore. That's what the other parts of the science say, if you're clearing the air of that CO2 to reduce it, you're also clearing, most likely, PM2.5 and PM10. Increased ventilation improves the quality of air.

I guess from our perspective—and maybe this comes from a perspective of trying to get the most you can out of the budget that you're given—it seemed to me that CO2 monitoring would provide a proxy for most of the other things. So establishing an appropriate amount of CO2 in a space where people are trying to learn, or in a public building, would be a way of actually taking care of the other things too, without having to establish all the standards that people want to argue about. Because I think we can generally agree that 800 parts per million would be a better level for CO2 than 1,400 parts per million.

The Hon. SUSAN CARTER: Just to track back to the SafeWork point, though, if I understand you correctly your submission is the Department of Education and schools are in breach of their obligations under the safe work Act, but there are no reports being made to SafeWork to initiate investigations because there's no number. How is it that you're asserting that they're in breach of their obligations to provide a safe place of work?

DAMIAN PURINS: I guess it depends what that would look like. When you say "no reports", we have a recent report to SafeWork from a TAFE campus in the Wollongong area where there's a clear ventilation issue. So we're looking at facilities there. The members didn't need to measure the amount of particulate matter in the air, just that the machine's operating and the ventilation wasn't working and there was an exposure. So SafeWork will come in and look at things like that. We haven't got a lot of evidence that SafeWork will come in and investigate the things that you're asking about. This isn't my opinion; it's a fact that there are no prosecutions against government agencies in areas like this. There have been none.

Even in areas of asbestos, where we know there are significant problems, we haven't got to prosecution. We have enough trouble trying to get the department to respond to hazards that we can see and are evident, and we have evidence that's plain, and then get enforcement action from SafeWork through some sort of prosecution for when things have gone wrong, let alone the ones that are invisible and people can't agree on the standard. There's a reason why you would pursue certain things and not others in areas where there's something we can report and think we could action, like at the TAFE I just referred to, where there was an order given by SafeWork because of the ventilation. Then we'll take action. But it's hard where it's an unseen hazard.

To the foreseeable risk piece, which is the department's responsibility, can we foresee that low-quality indoor air would cause a hazard to workers and to students? I would say yes, the science already supports that. Has the department collected any data about that? Yes, they said in 2021 and 2022 they were collecting data about CO2, and they said they would release it as soon as it was collected and completed. They haven't released that. That's part of the tabling of documents.

The Hon. SUSAN CARTER: If you're arguing foreseeable risk, are you arguing that the NSW Department of Education is negligent?

DAMIAN PURINS: If they have data that suggests that some of these—

The Hon. SUSAN CARTER: There's no need for data for negligence. They have a duty of care. If there's foreseeable risk, if they're not meeting that risk, the data is irrelevant.

DAMIAN PURINS: The primary duty of care would suggest that.

The Hon. SUSAN CARTER: You're not looking at bringing action against the Department of Education for negligence?

The CHAIR: Sorry, you've asked three questions in a row. Can we let the witness actually answer them?

The Hon. SUSAN CARTER: Sorry. It's one extended question.

DAMIAN PURINS: The answer is you're asking a question about something that we didn't really have the power to do until a few months ago, with the change of the legislation that the current Government has brought in to give greater powers of prosecution.

The Hon. SUSAN CARTER: Sorry, negligence—since 1932 you would have been able to bring that action.

DAMIAN PURINS: Your word was "negligence", in that sense.

The Hon. SUSAN CARTER: Foreseeability of risk is negligence. That's the concept.

DAMIAN PURINS: I do take your point. But foreseeable risk requires identification, assessment and control measures. You're suggesting that means negligence. I suggest maybe it could mean negligence, but what I would say is it means you should take action to try and reduce the risk. That's what I'm talking about. If you can foresee a risk, you're supposed to try and take action to reduce it.

The Hon. SUSAN CARTER: In terms of schools, who's the PCBU?

DAMIAN PURINS: The PCBU is the Department of Education, and the secretary of the department is the PCBU's most senior officer.

The Hon. SUSAN CARTER: And in independent schools and Catholic schools?

DAMIAN PURINS: You'd have to ask them. It depends on their structure. But in general, though, it would be similar, in the sense that a principal doesn't have control in the same way a CEO would have control of something. In all sectors generally—but that would depend. I would think there'll be some independent schools that would be considered that way. I don't know the answer to that, but not in public schools.

The Hon. SUSAN CARTER: Just as a practical question, if teachers had CO2 monitors in the classroom and the CO2 monitor registers high, what's the teacher meant to do?

DAMIAN PURINS: If the windows are closed, they should open them. If ventilation is installed and it's not working, this gives the information to take things to SafeWork. Ultimately, if the actions aren't taken—it goes to your question from before. We can take action when we have clear information and so forth. Something like that would give you a hazard potential to do something about that you can't currently see.

The Hon. SUSAN CARTER: But what's the thing? If the windows are open, what's the thing the teachers do? Do they take the kids outside? What's the next step, then?

DAMIAN PURINS: If that system existed and the things are in place that should be in place to have the air clear, then, yes, you would need to move to a different space. It may be the reason it's not clear is because there's something outside that's causing the hazard, so you wouldn't necessarily—I can't say you would move outside, but you would have some information to make a decision that wasn't just guesswork, I suppose. If it wasn't about opening the window or checking the ventilation or making sure something's turned on, then, yes, you would use that. You would have the information you need to leave that space with the students and get them out of what may well be a risky thing.

The Hon. SUSAN CARTER: What sort of extra training would teachers need to be able to interpret the data and make those decisions appropriately?

DAMIAN PURINS: Again, there's a range of things, and the scientists and the people that build the technology might be better-placed to say this, but if you have a look at the Boston Public Schools website, I think anyone can look at the colour coding they use to say low, medium and high. If you were trained to say high is dangerous, I think you'd be in a fair space. I believe some of the systems are a traffic light system. So if it went to a red light, I imagine—I've not used a system like this—would probably mean a risk. You would check the risk. If the windows were closed for some thermal comfort reason but you needed to flush the air out, you'd open it, if that was what the problem was. If it was something you can't identify, then I guess you'd have some information to say this room might be unsafe to be in and it's time to move.

MICHAEL de WALL: Can I just add too, the premise of the question underlies part of the problem, which is too often it's when there should be a systemic response and controls in place, we're relying on individual schools to actually take action to get things to happen systemically. Whilst I appreciate the technical conversation around negligence and the work health and safety aspects from the union's point of view, there really should be proactive duty by the department, including providing the data and the systems, so that individual schools have very clear understandings of when things are unsafe and when they're not and can act upon that, rather than actually having to also kind of lead in quite often a political process, where parents and teachers are working together to try and get the system to fulfil its obligations.

The Hon. EMILY SUVAAL: Thanks to you both for appearing today. I wanted to start with a question around the first recommendation that you reference in your submission, which is on page 3. It talks about regulated and enforceable indoor air-quality standards as outlined by the Australian Academy of Science—albeit, I haven't read their paper—being included in the work environment and facilities code of practice. Can I get your thoughts around that and whether that would be a sufficient step in terms of how that would apply to existing buildings, given our school infrastructure is what it is. It is of varying ages, stages and sizes, and different ventilation systems, if you like. How would you see that as having a positive impact? You said it provides motivation.

MICHAEL de WALL: I'll start by framing it by saying that, again, in a environment where there isn't adequate commitment to capital expenditure on infrastructure at numerous levels of government, it's compromised. Your question is basically asking for a compromised answer in terms of do we just put up with the current infrastructure, even if the data tells us that there are problems there. Obviously, there would need to be a significant process of capital works to bring about some changes in some contexts. But I think the first thing is getting the information right, getting the standards right and then having the investment to actually bring about that change. None of those things are on the table at the moment.

DAMIAN PURINS: Maybe a different way of thinking, and I hope it's going to what you're asking, but these things aren't fixed. Once they're established, the standards mean something and, if they're effective, they stay and, if they're ineffective, they get revised. Welding gases, for example, in high school technology, industrial art spaces and in TAFE—advice around that has changed over time, but you've got to start with some form of measurement in the first place in terms of the appropriate safety measures as well as the types of gases that people are exposed to. The same for other chemicals and gases. Things like formaldehyde, for example, in the current standards has been changed in terms of level of exposure. I think maybe the nurses spoke a little bit about that in your first hearing.

The presence of a standard means there's something for it to be assessed against, whether it meets or doesn't meet, and sometimes that requires infrastructure. The welding gases one is a good example because it meant there was a change in ventilation infrastructure and use of these materials, including in teaching spaces, driven by the exposure limits and the other standards. I don't think it's beyond the research that's been done to establish what might be safe standards and then, if they are effective, they'll sit where they are. If they're ineffective, they could be revised to something that's more effective.

The idea that these things don't change I think is a problematic idea. Where we see things like silica exposure, people have introduced standards and changed work practices and so forth. It doesn't start from an area of knowing what it is and then working backwards; it started from the exposure causing illness and there was a bit of catch-up being done. I don't think anyone who's learning about this space and the amount of information that's available, the amount of time we spend inside, thinks we're in front of the game here. I think we are playing catch-up. Establishing some form of standard is an important part of getting enforcement and driving change. I don't think it's just in buildings. Building standards may well be an answer—I'm not an expert in that area—but I tend to think, once the building's built, then it's what happens in the building afterwards that's more important. So it's monitoring in an ongoing way. What are we monitoring? I think the scientists have established some things we should be monitoring.

The Hon. EMILY SUVAAL: One of the earlier witnesses, Adjunct Professor Geoff Hanmer, in the submission they provided talks about Australian Standard 1668.2 throughout as being a good place to start in terms of the National Construction Code, so that may well be the place to start, as you've suggested. I'm interested in whether or not your members have told you about any schools or examples where this is done well, or whether you've got any standouts. We had evidence in our first hearing about a school that had initiated canaries, the Clean Air Initiative or Clean Air Network. Can you provide the Committee with any of that information and some of the improvements that have been seen?

DAMIAN PURINS: The federation is very supportive of the Cooler Classrooms Program, which started under the previous Government. I'm not an engineering expert, but the briefs for those systems include bringing in outdoor air and monitoring of the system using CO2 monitors and so forth. I'm not aware of our members often giving us positive stories about things. It's usually when things go wrong that we get engaged. But considering the number of schools that have cooler classroom initiative, including some very old builds, some heritage buildings and so forth, it's clear the department can do this work. That was about a temperature measure; it was only about thermal comfort and about heat for the installation. The fact that there are several hundred of those installations and we don't get complaints about them would suggest that people are happy with them. I would say to you that the information we've had over time from our State council and so forth is that pretty much all teachers would prefer a modern, clean working space.

The Hon. EMILY SUVAAL: Fair enough.

DAMIAN PURINS: We're after a statewide rollout of that program, not for individual schools.

MICHAEL de WALL: What we do hear from is schools that wish they were part of that program. There's definitely a need for wider investment in that.

DAMIAN PURINS: If we had that program statewide initially and that had been concluded, I don't know that we'd have a submission to make of anything like what we've made, because we would have monitoring in the classrooms, we'd have ventilation that could bring in outdoor air, we'd have thermal comfort organised. It is about the fact that the infrastructure is not up to scratch. Overall, as I said, if that program had been rolled out to every school, then we'd be in a different situation. We'd have some faith that the air was cleaner, that it was being filtered, and that outdoor air was being brought in, in a properly ventilated way. But that hasn't happened, so we're not in that space and we've got concerns about the spaces that remain—which is most of them.

MICHAEL de WALL: Just to understand, I guess, the barriers to achieving that more widely, we have schools that want to be part of that system, or have found money to do it themselves, but then they need significant

upgrades of their electrical systems because they can't cope with the new technology. The whole infrastructure question actually is very central to how this can be delivered over time, in some settings in particular.

DAMIAN PURINS: Like I said, as far as I'm aware, there aren't buildings they can't do this in. They're doing it in buildings that are over a hundred years old, sort of classic Sydney inner-city builds, or new builds that were built in the early 2000s that didn't have air conditioning installed. Brand-new builds will get it as a matter of course. What's left are all the other schools that don't have this capacity at the moment.

The Hon. EMILY SUVAAL: I presume it's certainly—we were talking earlier today about other measures and whether it would be the responsibility of a teacher, if we were to try and monitor it, to then put in place controls and things. I presume it's your evidence that teachers don't need another job and another responsibility in terms of everything else they've got to manage with curriculums and students, that they also shouldn't then be responsible for managing the indoor air quality within a classroom, and then instigating controls if it is the case that it's not up to scratch.

DAMIAN PURINS: We wouldn't ask other professionals, generally, to do that. But teachers are asked to do those things. Yes, that's our evidence, but even with all those things installed, I would still strongly favour a transparent monitoring system similar to the Boston public school system, where if there was an issue in a space that I was working in, I could take some action about it to protect myself and the children whilst teaching, rather than not know. I wouldn't like the idea of just relying on the mechanical ventilation without proper monitoring of what was actually happening inside the classroom for pollutants and CO2. Our evidence goes to both those things. Yes, we want better facilities in all spaces, but we also want to be able to monitor it because you can't take action to protect yourself against indoor air-quality issues unless you actually know what's going on in the air.

The Hon. SARAH MITCHELL: Can I ask one that follows up from that. Thank you both for being here. A lot of my questions I had have already been answered. I just wanted to get your view. We had an earlier witness who, in their written submission—we didn't actually talk about it this morning, but there was a suggestion for an awareness-raising campaign to teachers, parents and children about the impacts of poor indoor air quality and looking at things like curriculum-based activities for students, workshops for teachers and engagement sessions for parents. Would you have a view on something like that happening in New South Wales schools?

MICHAEL de WALL: It seems to me every time something comes up in the wider community, it gets dumped into the school curriculum for schools to take control of and deliver. Obviously, in a blunt assessment, that would probably be problematic. For teachers as workers, I think these things need to be authentically part of their work environment and part of their regular training and support to maintain safe workplaces. The extent to which that should become a curriculum issue is, I think, a highly problematic conversation. But going back to what Damian has already said around even just knowing what's going on inside your classroom in terms of air quality is the first step, and then having some agreed and simple procedures to implement, should there be a problem. That seems to me the smart place to start. I wouldn't necessarily be thinking that it would be helpful to expand the curriculum further with other items.

DAMIAN PURINS: Can I suggest as well, though, there are cohorts in the community that are already well aware of the concerns. As a deputy principal working in a high school during the COVID shutdown, reopening and so forth, we know we had students who didn't come back, with parents concerned about the health of their children. Many of those concerns remain. So that period of time, I guess, heightened people's awareness of pathogens in the air and for people with compromised immune systems and respiratory illness and so forth, I think we're still seeing the reality that that cohort doesn't need education about it. What they actually probably really need is information that says the rooms are safe.

The Hon. SARAH MITCHELL: That goes back to your earlier point about more transparency in terms of monitoring.

DAMIAN PURINS: If you lived in Boston, you could find out. But if you live in New South Wales, the department can gather the information, but we can't find out, because it's not published, and I think it should be.

The Hon. SARAH MITCHELL: You mentioned a few TAFE examples before, Mr Purins, as well. In terms of this being an issue that's raised by your members, in my experience, I think it would be more school teachers than TAFE teachers that raise this, for a lot of sort of practical reasons. Would that be a fair assessment, that this tends to be more of an issue impacting classrooms in schools as opposed to TAFEs?

MICHAEL de WALL: I think in the first instance you need to recognise that TAFE is not just the learning environment but that it actually replicates industry. There would be some very industry-specific concerns about air quality in different learning environments across TAFE.

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DAMIAN PURINS: The concerns are shared. Our TAFE council will talk about similar concerns, maybe actions taken in different ways, and they're dealing with a different community, I suppose. Working in your local community as a primary school teacher, it's a little bit different as a TAFE teacher, I suppose. The expression of the concern is different, but the reality of many of the buildings and the campuses is much the same. A teacher teaching adults English in a classroom situation faces similar issues. But I guess there is that difference, and often that will be sometimes quite a bit smaller cohort, and adults breathe more slowly than children, and when you fit 30 kids in a room that's smaller and they breathe more quickly, you increase the CO2 much more quickly. I don't know. That sort of lived-experience piece that Michael mentioned in his opening, my lived experience of my kids in preschool or care, primary school, high school, is that you put kids together that are sick, then everyone gets sick.

The Hon. SARAH MITCHELL: I think that's universally acknowledged.

DAMIAN PURINS: Yes. The phrase "foreseeable risk" came up before. I think that's a foreseeable risk. We know that those things cause harm. and we know that cleaning the air can improve that situation. I don't think it should be about individual cases. That's a shared system responsibility that I think we can do something about, for everybody. It benefits everyone: public spaces, preschools, primary schools, high schools, TAFEs. If people have clean air in those spaces, I don't see what the downside is. We can do better at measuring and doing something about it.

The CHAIR: That was a beautiful note to end on. Thank you again for the time you've taken and for your evidence. If there are supplementary questions, the secretariat will be in touch about those.

(The witnesses withdrew.)

(Luncheon adjournment)

Mr BRYAN JEPSEN, President, Indoor Air Quality Association Australia, sworn and examined

The CHAIR: Thank you for making the time to give evidence today. Would you like to start by making a short opening statement?

BRYAN JEPSEN: Thank you for the opportunity to speak today on behalf of the Indoor Air Quality Association or IAQAA, as we call ourselves. Floods, sewage ingress, bushfire smoke and water damage are not rare but are predictable parts of our climate cycles. Catastrophic events don't just damage buildings; they fundamentally change the air we breathe in indoor environments. Our submission highlights that, despite the risks being well understood and preventable, most buildings still lack the systems, standards or response frameworks needed to protect occupants in these events.

It is our position that a building must function as a refuge during periods of poor air quality. However, indoor air quality can be affected by external events as well as internal sources of contamination. These can include viral, fungal, bacterial and chemical hazards. Without mandated policy requirements, inconsistent building recovery practices and inadequate controls against outdoor pollutants can leave workers and the public at risk of unnecessary exposure. Under the workplace health and safety regulations, every person conducting a business or undertaking already has a duty to ensure that people are not exposed to airborne contaminants. This duty applies to all building types and includes an intent to protect workers, visitors and the public.

Indoor air shouldn't just be a comfort feature, but an essential component of a building's safety system. If we want buildings to remain resilient during bushfire smoke events, viral outbreaks, internal catastrophic impacts or simply fit for everyday occupancy, indoor air quality should be treated with the seriousness it can bring. This perspective not only supports economic productivity but also provides a truer refuge when it is needed most. With that, IAQAA thanks those who have initiated this inquiry and also those who are participating.

The CHAIR: I was interested in the part of your written submission that specifically related to water damage and subsequent susceptibility to microbes and bacteria, mould, fungus et cetera. This is an area the inquiry hasn't gone into yet in much detail. We've got a few other witnesses this afternoon who are interested in this area. I was hoping you could talk us through the problems that you see with current responses to water damage in terms of the impacts on air quality and some of the recommendations that you're making in that space.

BRYAN JEPSEN: The impact from water damage can bring with it a biological life form of ecology that can evolve because of it. It provides the environment where these can amplify. The amplification of these organisms then, through part of their life cycles, become aerosolised as part of their cycle, so they grow on surfaces and then, as part of their growth stages, at some point they will disperse themselves to try and find newer, greater ground to overtake and then occupy. The mould and bacteria evolution when water damage occurs to a building can then impact the indoor air quality and, therefore, also those who occupy it.

How it stands at the moment is we do have, as of late last year, two standards when it comes to water damage recovery of buildings, so how they should be recovered. IAQAA and a few others sat on a committee to bring that into passing. That was an adoption of an American standard through the IICRC, and these are called the S500 and the S520. What they do is they stipulate the response that should be given as a best duty of care, as an industry response to that. What it doesn't do, however, is it doesn't take into full account the measurement of those risks, just the mitigation side of the response to those events. That water damage can occur from something such as a burst pipe. It can be sewerage water backup, it can be floodwater entering a building, or it can come from above from strong wind events and rain and enter through the facades of buildings. That consistent dampness causes the building material to then be the breeding ground for these microbes.

The CHAIR: You mentioned those very new standards. You're obviously recommending some solutions above and beyond even those new standards that have been put in place. Can you talk us through what you see as the gap in that new standard or what we should be looking at trying to fix?

BRYAN JEPSEN: Absolutely. The standard doesn't necessarily have a gap in that it is a very suitable document for the recovery of a building, but it is only about how a building gets recovered, not how it is measured. It's not prescriptive in what is meant to be done after such points. It will outline that there are certain professions, such as what my industry and IAQAA and its members represent—that we are called indoor environmental professionals or indoor environmental consultants, depending on where it sits on the gamut of things. It refers to us, but it doesn't mention how the steps are to be taken to validate so much that the restoration work has been satisfied. There are steps that are taken to dry the building, remove the materials and also clean what might be a microbial risk. Then it says to have it tested or validated by a third party. It leaves that gap and that's where it stays. In that, there is a bit of contention about how that gets validated. That's where our association comes in and tries to set the industry standard and bring out white papers and positions such as that.

The CHAIR: In your view, what is the standard that you should be testing to?

BRYAN JEPSEN: The standard that we should be testing to, firstly, deals with the material being properly removed. If it was contaminated or damaged and cannot be recovered then it should be discarded. Then the property or the building and its materials should be structurally dried. Following that, at some point microbial growth can occur, from as little as 48 hours after a water damage event, where these microbes start to take hold, and then as I mentioned through their life cycle can become aerosolised. So part of the validation process for that would see that the materials have been removed as designed by the guidelines. It would also see that the structure is dry and satisfies that criteria, and it is visually free from any debris or contamination.

But we are looking at something that is microbial, so it is something that you look at under a microscope. There is only so far our eyes can take us to, even with glasses, and then it goes into the unseen where our eyes can't take us. What that then would require, as I see it, is that we would need to clean the air because of the disturbance that occurs, and it can re-aerosolise everything, and then filter that out. Then it is proving that those filtration methods have been satisfied and that the contamination hasn't gone beyond the point of damage, so therefore impacting other areas. The risk that can occur, especially in large or commercial properties, is their air-conditioning system—their heating, ventilation and air-conditioning system; I'm sure you'll hear a fair bit about that today, or HVAC system—

The CHAIR: This Committee was at Newcastle on Friday talking about the Calvary Mater Hospital.

BRYAN JEPSEN: So the HVAC system is designed to recirculate a lot of the air. In that, if there is a contaminant within the building, amplifying and not being filtered out or addressed adequately, that can then potentially disperse into what would be the lungs of the building and spread that to other locations.

The CHAIR: Coming back more broadly to the range of other pollutants you've identified—and many other people have talked to us about the same risk of pollutants—there was a discussion earlier this morning about the technology that exists to measure these things. We've heard that it's changed quite a bit in recent years. How easy or difficult is it to measure these things, if you were called to assess the indoor air quality of any given building?

BRYAN JEPSEN: To speak more broadly, a lot of the discussions I have seen so far regarding this is largely around the chemical side of things—your carbon dioxide, carbon monoxide, PM2.5, which is a particulate, and PM10. These particulates are actually readily available to be tested. The technology is definitely there. There are ranges of how this gets done. On our side of the fence, when it's a practitioner-based scenario, we have calibrated tools that we bring with us to the site that are validated and checked at least annually, so we know that they have not seen any sensor drift, and if they have then they can be repaired.

On the more installation side of technology, there are low-cost sensors—"low-cost" could be another name for cheap—and these can see sensor drift. These aren't often validated, and in our submission we also highlighted that these should be validated as well, because as much as they might be great for monitoring as a baseline of what is going on, if there is something that has occurred where there is a risk, those sensors are not qualified enough to measure the actual risk if there is a risk to people or the building. At that point, we would bring in individual tools that can specifically measure these parameters. The access is definitely there, the technology has absolutely got there and, when it comes to the building's management of that, there are definitely technologies that are a bit more evolved in recent years that can also help manage that. Not only, as I mentioned before, can the air-conditioning system potentially disperse a contaminant but it's also one of the key solutions to it, with this technology.

The Hon. SUSAN CARTER: Just following on from the questions from Dr Cohn, we've heard a lot this morning about sensors, particularly in the setting of a classroom, and the desirability of having, for example, a CO2 sensor in the classroom. I think what I just heard you say is that they are useful as sort of comparators but they're not really effective detection tools—or am I misunderstanding what you said?

BRYAN JEPSEN: That's true. These low-cost sensors are available and they can determine a baseline. If they are set up in the right position, and if they are set up correctly and calibrated from the beginning, they start at a very good place. From our side, as the consultant, we can't be present through the whole period of an entire school class; there are not enough resources for that. These low-cost sensors can offer a constant evaluation of what that looks like. They offer a very good outlet as a baseline, but they need to be proofed, because they will drift.

The Hon. SUSAN CARTER: What does "drift" mean?

BRYAN JEPSEN: It's the calibration, so how sensitive it is. It might be true at one point, but then if you were to check it six months later, it might be out by a correction factor of a number.

The Hon. SUSAN CARTER: It's similar to the way that scales in shops need to be checked regularly for accuracy.

BRYAN JEPSEN: Exactly the same. Yes, same concept.

The Hon. SUSAN CARTER: So if we were to recommend that these monitors be in place, for example, we would also need a process of regular calibration.

BRYAN JEPSEN: I would agree, yes.

The Hon. SUSAN CARTER: Who would be the person who could calibrate?

BRYAN JEPSEN: That would be our industry, where we, as a trained consultant with calibrated tools, can come and validate that. There may also be other solutions from the manufacturers of these devices. They may have a solution to re-zero it, so that's re-centre it. That may satisfy the criteria. Each manufacturer might have a different solution that way. However, I would support that it could be validated in a stronger manner or replaced. As mentioned before, they are a low-cost sensor, so if they do see some drift, it may actually be more affordable to see their replacement than it would be to have it validated and recalibrated.

The Hon. SUSAN CARTER: And you said that they should be set up correctly in the first place.

BRYAN JEPSEN: Yes.

The Hon. SUSAN CARTER: Is that a job that a classroom teacher could do? Would it need somebody from your industry to do that?

BRYAN JEPSEN: I think if there were some guidelines for that, by and large, you could get it 80 per cent correct with guidances. That would be sensor height, sensor location and looking at potential pathways that might cause the changes, so yes, I believe that there could be some practical solutions.

The Hon. SUSAN CARTER: What do we do about the other 20 per cent, though?

BRYAN JEPSEN: Professional interventions may serve that purpose. What I would like to highlight, though, is that even though we're talking specifically about carbon dioxide sensors, it requires quite a lot of carbon dioxide for it to be quite detrimental. For example, in nuclear submarines they have a requirement that the CO2 does not pass 7,000 ppm. We have other guidelines, as you will have seen, that we are talking around the 800 to 1,000 mark before it starts to impede cognitive ability. However, if it is suitable for a nuclear submarine to go up to such a threshold, having a sensor put in a 20 per cent slightly incorrect location—the ramifications of that are potentially not that noticeable.

The Hon. SUSAN CARTER: Do I understand that the threshold for a nuclear submarine is almost 100 times greater than the sort of threshold that we're looking at?

BRYAN JEPSEN: Seven times.

The Hon. SUSAN CARTER: Wow. That's quite a variation, isn't it?

BRYAN JEPSEN: It is, yes.

The Hon. SUSAN CARTER: One of the issues where I am struggling to reconcile with the evidence that we've been receiving is that I think everybody acknowledges the importance of data and everybody acknowledges the importance of testing to get that data, but there seems to be a range of different standards that are being postulated. Can you help us? Is there a standard that we should be looking at?

BRYAN JEPSEN: Yes. Forgive me if I have confused the issue a little bit there.

The Hon. SUSAN CARTER: I am not a technical person.

BRYAN JEPSEN: That's okay. You have to remember that these people on a submarine, for example, are trained and are in high-stress situations, so their threshold for general tolerance under extreme circumstances can go a bit higher. However, what we look at when we talk about carbon dioxide—I would also add in there a particulate size of PM 2.5, that's 2.5 micron, is a critical metric with both of them side by side. Where CO2 has been used quite significantly in the past is that it was a metric for measuring clean air. However, we now understand—and I'm sure that you will have come across a bit more—that it's a bit more nuanced than just a simple CO2 sensor because you can have pure fresh air coming into a building, but say, for example, it is closed up and someone happens to have a virus, that virus, just because you have the CO2 clean, doesn't mean that the air is without risk.

There are other metrics that are used, but there are a lot of great studies that have come out to show that when carbon dioxide starts to meet certain thresholds—around those 800 to 1,200 or 1,500 mark—then the risk,

if there is someone who might be a zero source, can then cause other impacts to those who are occupying the same space. It is a gradient of risk.

The Hon. SUSAN CARTER: Is there a set of standards? Is it the WELL standard? Is there a WHO standard? Are there standards that are in use in tunnelling industries, for example, that we can adapt? Is there a set of standards that we can say, "This would be a sensible set of standards for us to adopt in New South Wales"?

BRYAN JEPSEN: Yes. In our statement, we have agreed that the World Health Organization statements are quite acceptable for what we believe would be thresholds within those parameters shared.

The Hon. SUSAN CARTER: Did you look at the WELL standards?

BRYAN JEPSEN: Yes. WELL is very close to this. The WELL standard is a building rating system. I believe you've spoken to them this morning. They use studies to back up their numbers as well. One of those studies will have definitely been the World Health Organization's position, so it would be, in my opinion, more prudent to follow the original source or authority than a secondary building rating system adoption of that.

The Hon. SUSAN CARTER: I was very interested in your submission to read your comments in relation to HVAC systems and the dangers of an improperly maintained or improperly cleaned HVAC system. Are there standards that we can mandate? Can anybody adequately clean an air-conditioning system? What are the parameters we can put in place to make sure that these systems not only are installed but are running appropriately?

BRYAN JEPSEN: Yes, there are, actually. AIRAH, who I believe you're hearing from later on today, they bring out a bunch of guidelines and they have some really great guidelines. To begin with, one of them is what's called the DA19. That stipulates how HVAC systems should be maintained. That goes not just to the hygiene side, which I'm going to talk to, but it goes to its function and the servicing of that. When it comes to the hygiene, AIRAH also have a guideline and that is being revised at the moment as well; being updated. That came out in 2010. It's called the AIRAH HVAC hygiene guideline. It was the first for a while to bring out guidelines for evaluating its hygienic condition. That includes the dust load and the fungal contamination that can happen around moisture-producing components. So that can be around the fan, the coils and also down the duct work where sweating or condensation can occur, feeding then the microbial risk that occurs there. On top of that, and more recently, came the ANSI/IICRC S700. That also follows along a similar line of inspection.

When it comes to, at that point, applying those evaluation protocols, a cleaning protocol can be brought into place. There are different kinds of air-conditioning systems that require sometimes some special equipment or consideration for how they are put together, so that they can clean those things. For example, a split system that you would commonly find in a house cannot be treated the same as the air-conditioning system that is here. They are different form factors serving a similar outcome. Can these be recovered? Yes. There are associations that govern this, largely from America. One of the key ones, though, is NADCA. They bring out guidelines for how these should be cleaned and they also have a licensing program. However, you have to go to the US to do that. In Australia we don't particularly have that, yet we follow and adopt those guidelines here in Australia as they are best practice.

The Hon. SUSAN CARTER: Are there standards or practices already in Australia that, for example, hospitals, schools, government departments would be aware of and would be using currently?

BRYAN JEPSEN: There are potentially. I'm not too familiar personally with New South Wales guidelines for that. However, in Queensland, they do have what's called the AC14. That requires that the HVAC systems be evaluated annually and then put to the facility's managers to then apply a budget for rectifying any critically impacted—

The Hon. SUSAN CARTER: I'm curious about Queensland, given the size of the State and the different climatic conditions between the wet north and the Sunshine Coast, and with fungus and mould around water and damp. Do they have the same standards that apply across the whole of the State?

BRYAN JEPSEN: Yes, they do. What comes with geography and different typologies is that humidity that you mention, and the proclivity for condensation. So inside of an air-conditioning system, the risk would be very similar no matter the climatic zone, depending on how much humidity they're trying to pull out of that system. When it comes to an HVAC system and the treatment of mould, no matter the type of mould or the type of bacteria, the treatment is the same. All of these protocols that have been developed, it doesn't matter the type, genus or species; the cleaning protocols satisfy all of those.

The Hon. SUSAN CARTER: Do viruses ever live within air-conditioning systems in the way that you've just described bacteria are capable of?

BRYAN JEPSEN: They can because how viruses come to transport is through bacterial adoption. So they embed themselves and their DNA into a bacteria.

The Hon. SUSAN CARTER: Is there any such thing as a viral cleaning protocol?

BRYAN JEPSEN: During COVID there were protocols when it came to how we would evaluate that. IAQAA worked with a bunch of people, including those internationally, to develop a guideline that would outline how to validate that something has been cleaned, because general cleaning protocols do satisfy, and the same as the solutions that they may use. The protocols that we do have in place and the chemicals and different products as well as technology—I can't ignore that part—there are solutions that can solve the viral risk as well. So, yes.

The Hon. SUSAN CARTER: Is mould something that is a risk with air conditioners if they're not cleaned properly?

BRYAN JEPSEN: Yes, absolutely. Because air-conditioning systems, if their filtration systems allow some bypass to occur throughout the system, it can leave particulate inside of it. That particulate provides then the substrate. Because an air-conditioning system produces a fair amount of moisture and it changes what's called the psychrometrics inside the system, it may cause that condensation to occur, therefore giving it not only the substrate to consume. If the mould is already present and has bypassed the filtration systems—which they can—they then have been given an opportunity. By and large, HVAC systems, if they're not seen, it's not dealt with. Just because you can't see it and it's in the ceilings, it doesn't mean that it's not an evolving environment that's a potential risk. It also has within it biofilms, especially around the cooling coils, that can harbour some of these.

The Hon. SUSAN CARTER: And how often should cooling coils be cleaned?

BRYAN JEPSEN: That's set out by the AIRAH HVAC hygiene guidelines. Depending on what kind of system it is and its condition, typically, annually. Sometimes it can be as low as quarterly for critical environments such as operating theatres or pharmaceutical environments, where either critical persons or assets are being served by that system.

The Hon. EMILY SUVAAL: Thank you for your evidence so far and for appearing. I want to ask, firstly, in your submission, you've got a very useful table—table 1—which is the common pollutants and pathogens in indoor buildings. You mention at the bottom relative humidity and its importance in influencing a number of the listed contaminants. Are you able to expand a bit more because it's something that we haven't really touched on as a Committee yet. We've been talking more about what's in the air in terms of carbon dioxide—the list of contaminants. How does that impact some of these other things?

BRYAN JEPSEN: Water being in the air is relative humidity. Depending on the temperature and the amount of moisture in the air, when we measure that, that is either relative humidity or absolute humidity. That is either a measurement as a percentage or it is a weight per kilogram of air. When there is more moisture in the air, there is a risk that some of these components can off-gas in a way, so it can cause a reaction chemically that can release these components into the air more readily than they would if it was in, for example, a very cold and dry environment to a wet and humid one. Depending on the particular parameter we're talking about, it can influence that.

When moisture is in the air, it can also cause a bit of a flocculation. That's where a filtration occurs where molecules attach to other particulates, making them larger, therefore causing them to drop more readily or be captured in the filtration system. In some ways humidity can be great, and in others they cannot. For example, when it comes to viral outbreaks, it was found that a more humid environment when it came to COVID, it wasn't able to sustain itself as well in a more humid environment than in less of one. On one hand, humidity can be great, and on another hand, it can cause a thing. However, there is a balance for relative humidity that has been around for older than I have been, and it hasn't really changed a lot since then. That would see between about 40 and 60 per cent as a window of best.

The Hon. EMILY SUVAAL: And your typical HVAC system, well-maintained or whatever, should maintain the relative humidity within that window. Is that correct?

BRYAN JEPSEN: That's what it should serve as, yes. Do they all do that? No. Sometimes systems are not necessarily designed appropriately enough, where they might be under- or over-serving this moisture issue, so it either pulls it out or it permits it through or, over time, if it's not maintained or if the use of it is improper to how it was designed, it can cause that threshold to move.

The Hon. EMILY SUVAAL: I want to ask you now about the NABERS framework because it's something that I asked witnesses about earlier today, but it's also referenced within your submission as a recommendation to extend NABERS/WELL/LEED-style indoor environment rating system schemes to include

an indoor air-quality star rating that is made public. I'm just interested in terms of the star rating system what you think that would include.

BRYAN JEPSEN: Of all the parameters that we've spoken about, and you've spoken to the WELL Building Standard this morning, when we refer to NABERS, because it is our Australian, although Commonwealth, branch for building performance ratings, we see it as a good platform to be able to leverage these protocols or thresholds that we're seeing and to be able to rank them as being good, proper or great, or however the stars might want to be put, but see that they are satisfactorily met. We mentioned NABERS because not only is it our nation's building rating system, but we feel that with a bit of expansion towards their authority, I don't believe that there would be any hesitation for them to be able to take it on for commercial buildings and then offer that publicly to people who might want to know if this is a safer building for them than not, or do they care about air quality or do they not. For some, that might matter.

The Hon. EMILY SUVAAL: It's an interesting suggestion and one that witnesses earlier today also had. My final question is around another of your suggestions for HVAC solutions for retrofit and ongoing operations. You talk about legislating mandatory HVAC hygiene maintenance schedules aligned with the Australian standard 3666.2 and you also mentioned the AIRAH hygiene guidelines. At the moment, what are the current requirements for operators around that maintenance schedule, or is there no requirement?

BRYAN JEPSEN: There is stipulation when it comes to tenders or tendered work for large HVAC systems where there will be an outlined requirement of the mechanical servicing contractor, so the group that is maintaining the systems and making sure that they function, as I mentioned typically using the DA 19. In that it says that the HVAC system should be visually evaluated for any contaminants.

The Hon. EMILY SUVAAL: Visually?

BRYAN JEPSEN: Yes, that's the extent of it. You must recognise that these people are mechanical service providers. Their training for the purpose of the role is to make sure that the air-conditioning system functions; it doesn't stop. It doesn't necessarily go into training or upskilling, or even the expertise to be able to qualify them to serve that role of a visual inspection. As a layperson, you might know if it's becoming out of control, but they don't go and evaluate the extent of the air-conditioning system. That's not part of their contracts typically and it's not mentioned in the DA 19. You have the DA 19 and a slight separation where it goes into HVAC hygiene, so it says that if you see an issue you should then take next steps, but that next step jump requires a third party, such as the members of IAQAA, to jump in and serve that role. That may include not only the visual inspection, but it may also include other laboratory analysis protocols which these people who serve the DA 19 are not qualified to do.

The Hon. EMILY SUVAAL: A visual inspection is quite a broad term. If I stuck my head in and looked at it, that's a visual inspection.

BRYAN JEPSEN: And that's about the quality you get, because they only get a complaint if the air conditioning stops or isn't as good and then if it goes critically bad inside of a building. Once it's gone critically bad, not only has the air-conditioning system been compromised but also potentially the people and the assets that are within that building, so you might see books, tables or chairs become fungally contaminated because there was that slight gap of, "I looked at it and it works okay. I've got to move on to the next unit because I have a schedule." There is a quota that they have to serve, and unfortunately, not a lot of weight, in my opinion, is given to the purpose of that one line of a visual inspection.

The CHAIR: Something we haven't explored in great detail yet is healthcare settings specifically. Obviously, hospital-acquired infection is a terrible problem, and it's back in the public consciousness after what's happened at RPA Hospital. Are there particular recommendations you think we should be considering in those healthcare settings, where you've got a combination of unusual or particularly potent pathogens that could be airborne, as well as people with unique vulnerabilities to those infections?

BRYAN JEPSEN: Yes, absolutely. I would see, if it's not already present here in New South Wales, that a similar program be adopted as Queensland have with the AC14, where the HVAC systems are inspected annually by someone who is qualified, and then further to that, potentially giving the budgets above what is already provided to facility management, specifically for air quality. This can include, then, the remediation of compromised units, but it may also include maybe every now and then a grant or something along these lines, especially for ICUs, operating theatres, these critical infrastructures, that their systems especially be focused for upgrades that will see technological implementations.

I'm not sure how much everyone is aware of this, but there are the filtration and air cleaning technologies that can be implemented into the already existing air-conditioning infrastructure that can be on top of that. They do come with an energy draw from those things. They can be things such as ultraviolet light, UVC, or plasma

technology has come back. Previously, it used to draw so much energy that it was extremely inefficient to run them. However, there have been refinements to the technology now. They've always been very successful at filtration, but now the energy draw from those things have come into a place where it's now more viable to that when it comes to energy that will come onto the building. For those that are not critical environments and have a NABERS rating, that will also have an impact, and potentially a negative impact, for that, so if NABERS were to be introduced to this thing, it would be a factor that they might take into their calculations for that.

The CHAIR: You mentioned germicidal UV. It's been mentioned in a number of written submissions, but we haven't really discussed it in hearings yet. How easy or difficult is it to retrofit that into existing systems in those high-risk settings?

BRYAN JEPSEN: It's quite simple, to be fair. They are like fluorescent bulbs. We don't really see them nowadays too much because we've gone LED, but if you're familiar with the fluorescent bulb, they're a similar design to that. There are different brands that have different outputs. However, what occurs is they stick these UV germicidal light bulbs near the cooling coil, where a lot of the biofilms can occur, and it keeps the cooling coil more specifically—and they've served what's called a plenum, or the box that they sit in, very well for reducing any microbial growth or accumulation. That's one way that they get done. The other way is they get stuck into the air-conditioning duct itself, so they get stuck in lengthways, and depending on the velocity of air that goes past them, because different organisms have different strengths to resistance of UVC, they will use indicator organisms, let's say, to be able to—at what point will they die?

They must pass these bulbs at a certain amount of power, so then that power can essentially inoculate those organisms as they are passing by. That is one way for UVC to work, that way. They do, though, become at risk of fouling. That is, when particulates eventually accumulate on top of those bulbs, those bulbs become less and less efficient because they are then occluded to be able to emit their full power. Secondarily what occurs is, just like every other light bulb, it will lose its luminosity over time, so they may see a replacement cycle gone through to be sure that they can kill the target organism at the length of time which they're trying to achieve. Those are the two ways that they are typically involved.

The Hon. EMILY SUVAAL: What's the cost, roughly, of that?

BRYAN JEPSEN: That is not my space so much. I used to sell them when they first came to shore. Depending on the size, you can have a small unit the size of the television you're looking at, but then you can have some half the size of this room, so you can understand that the amount of bulbs required can vary. There are some companies and manufacturers that do it rather intelligently using mathematics to be able to determine how long, so how many bulbs are required and, at the end of its lifespan, would it still be efficient even with fouling or drop-off that occurs from the energy? The cost can vary but, roughly speaking, $10,000 would put you in the ballpark. But, like I said, I haven't done this for a very long time. That's per unit and depending on how many units serve. Say, for example, there are four units that serve an area. That would be four times that, or if, for example, a larger unit could serve the same area but it's only one, the cost would be probably half of what it would be for all four. The configuration matters and I'm afraid it's not one size fits all.

The CHAIR: We've had a number of submissions from industry, so I wonder if that's a question to come back to on another day.

The Hon. EMILY SUVAAL: Yes.

The CHAIR: I want to come back to the question of the HVAC systems in hospitals because I think that was potentially a very important bit of evidence. Can I clarify that your evidence is that we have HVAC systems in hospitals across New South Wales that, in your view, are not being maintained to the appropriate best practice standards?

BRYAN JEPSEN: Yes.

The CHAIR: You've given me something to ask Health about when we inevitably hear from them.

The Hon. SUSAN CARTER: Is aspergillus mould something that could be exacerbated or could live in HVAC systems if they weren't properly cleaned?

BRYAN JEPSEN: Yes, absolutely. Aspergillus is one genus that sits in a plethora of other genuses that go there. The reason why I believe you might be bringing this up is because it's one of the leading causes of infection when it comes to those who are immunocompromised. When HIV was not managed, it was the leading cause of death for those who had HIV. It was the primary organism that saw someone's end. It can be a very critical organism and can definitely be in the HVAC systems, as well as other water damaged buildings. It is very common for that to be there. I would also highlight that you will have it in this room.

We cannot necessarily get rid of it, but when it becomes a problem, depending on the vulnerability of a person, is when there is an amplification of a particular organism, the microbiome of whatever that state might be, whether that's the building's occupied space, the HVAC system, a wall system, however it might be—when that environment goes into what's called environmental dysbiosis, it's when there is a shift of balance. Normally, organisms balance themselves and keep us at bay of any risk. Good bacteria and bad bacteria fight each other, the same as mould, this stew of organisms keeping each of them in check. But when that dysbiosis or imbalance occurs, that's when the risks come to, firstly, a vulnerable person. That could be those who are on medication or cancer treatments. It can be children or the elderly. Whenever the system of someone, or their immune response, is weakened, they may then become susceptible to other environmental factors.

The Hon. SUSAN CARTER: I think you said earlier that one of the appropriate maintenance steps to guard against aspergillus would be to clean the cleaning coils on a regular basis.

BRYAN JEPSEN: It would be to review the HVAC system in its entirety. Yes, the cleaning coils do harbour a lot of biofilm. However, that is one component of potentially hundreds of metres of a system.

The Hon. SUSAN CARTER: And how often would you recommend that the HVAC system be reviewed in its entirety to guard against aspergillus?

BRYAN JEPSEN: Annually.

The CHAIR: There being no further questions, thank you very much for your time, again, to give evidence. If there are supplementary questions, the secretariat will be in touch with you about that.

(The witness withdrew.)

Mr DAVID LARK, Principal Microbiologist/Mycologist, NSJ EnviroSciences, before the Committee via videoconference, affirmed and examined

Mr VINCENT NEIL, Principal Consultant, Mycotox Australia, before the Committee via videoconference, sworn and examined

The CHAIR: Thank you for making the time to give evidence today. Would either of you like to start by making a short opening statement?

DAVID LARK: To the Chair and members of the Committee, thank you for the opportunity to provide evidence to this inquiry today. I'm a consultant mycologist and environmental microbiologist with over six decades in the scientific community. More than three decades have been in investigating moisture-damaged buildings and indoor contaminants. My work focuses on understanding how moisture within buildings allows microbial growth to amplify indoors and how those conditions can affect indoor environmental quality and building habitability. The key point I hope to convey today is that microbial problems in buildings are fundamentally moisture problems. When water enters or persists within a building material, microbial growth follows. For that reason, effective prevention and remediation requires identifying and controlling moisture within the buildings as they exist.

VINCENT NEIL: Thank you, Chair and members of the Committee, for allowing me to speak. Clean indoor air has been dominated by the word "mould". Hygienists and mycologists routinely focus their testing programs within damaged environments. Very rarely do they look at VOCs, chemicals used for cleaning, garden sprays like Roundup and bacteria. Our industry, of course, is led by various doctors of mycology and they're focusing on mould. Let me tell you, bacteria is one of the major driving forces in a contaminated building. Research into chronic inflammatory illness and gene expression patterns in susceptible individuals in water-damaged buildings is actually indicating that a large proportion of that inflammatory response is not primarily driven by mould. In fact, 42 per cent has been associated with Actinomyces exposure and around 28 per cent with bacterial endotoxins. In other words, bacteria, not necessarily mould, is the major driver of illness in contaminated water-damaged buildings.

Despite this, very rarely does anyone look at bacteria. Just recently the Mater hospital here in Newcastle concentrated on mould. There was no attempt to look at levels of bacteria and what types of bacteria. I would have thought, in a hospital, that would have been far more important for the health of those occupants. So the emergence of next-generation sequencing has actually allowed us to reveal microbial bacterial communities that provisional testings would never detect. What we're seeing, it's a little scary—for example, cyanobacteria, you will see it as blue-green algae, perhaps, which has been linked to MND in current research. Rarely do we find it in dry homes, but it's there in water-damaged homes, and in some cases at extremely high levels.

Legionella—you will think of cooling towers. But legionella, we find in damp buildings. We don't find them in dry buildings. Even more concerning is growing evidence that some bacterial species associated with, say, farmer's lung disease have been found in water-damaged buildings. I would like this inquiry not just to concentrate on mould but to look at bacteria, because if we don't, we're leaving many affected people to lose their ability to work, struggle to care for their families and face enormous barriers to having their illness recognised. The majority of these people come from low-income and our First Nations community. These are the areas, I believe, that NSW Clean Air need to look closely at and ensure the Government takes notice.

The CHAIR: I'll start with a couple of my own questions to either or both of you, whoever would like to answer them. In terms of mould and/or bacteria, are there other jurisdictions that we should be looking to who have better frameworks or standards in place?

VINCENT NEIL: It's an area which is developing. The group overseas that we're involved with are looking at the gene expression patterns. I hate to say it, but it is possibly emerging that autism may be associated with bacterial endotoxins, whether during the pregnancy or in the first couple of years of life.

The CHAIR: I'll just steer you back to my question. I suppose I'm interested in either air-quality testing or monitoring standards or building codes or regulations, if there are particularly other jurisdictions that do better with regard to dampness that creates these environments.

VINCENT NEIL: David? Which side is the IICRC?

DAVID LARK: Can I have the question again, please?

The CHAIR: The question was with regards to standards either for testing and monitoring or building codes with regards to dampness that creates a risk for biotoxins—if there are other jurisdictions that do this better that New South Wales can point to, either other Australian States and Territories or anywhere overseas that has

better regulations or standards that we should take a look at. If you'd prefer not to answer that question, I might go to my colleagues, if they've got further questions.

The Hon. SUSAN CARTER: Thank you both for being here. I'm not sure who's best placed to answer this question, but whoever feels able to. We've heard from a number of witnesses and one of the issues we're exploring is what appropriate standard should be set, and of course we need to measure regardless of whatever standards we choose. One of the measuring tools that has been suggested to us often is a CO2 monitor, not that it's perfect but it's a good indicator, and it's relatively inexpensive and relatively simple to use. Would a CO2 monitor, for example, pick up bacteria? Would it pick up any mould?

VINCENT NEIL: A CO2 monitor may indicate bacterially microbial activity. It can't indicate whether it's mould or bacteria or which species are there.

The Hon. SUSAN CARTER: Is there any form of monitoring that you can suggest that would be feasible, and by feasible I mean able to be rolled out across a number of different settings and able to be relatively simply used, that would detect bacteria or mould at any appropriate levels, as far as you're aware?

VINCENT NEIL: When you start measuring bacteria and/or mould, there are various ways to do that. You can do air sampling et cetera, but what has to be understood is that these microbial organisms have their own biofilm. That biofilm is to allow it to adhere to surfaces—also to protect itself—to absorb moisture out of the air. What you measure in the air is not really reflective of the total microbial load in a building.

The Hon. SUSAN CARTER: Just as a practical thing, what we're exploring is what are the appropriate standards that should apply in buildings, how do we measure those, and then what's the appropriate action to take? Excuse me, because I'm not a technical person, but I think what I'm hearing is that different bacteria will have different loads in different environments, so it would require individual testing, or am I misunderstanding your evidence?

VINCENT NEIL: No. Moisture will determine what microbial organisms are going to grow and develop in a space, in a home, workplace et cetera, but if you look at how much humidity is there, how much surface moisture, they're very good indicators of what may be a contamination, and the cheapest one.

The Hon. SUSAN CARTER: Can I ask you about humidity, though, because if you think about Cairns compared to Sydney compared to Melbourne, there will be different environmental humidity. Would that always indicate a risk factor for bacteria? Are there not some areas that are just naturally more humid and we would be testing for the wrong things in those areas?

VINCENT NEIL: You're right. In various areas, like if you go up to Queensland where the humidity is higher, then you're going to have greater development. Those people with susceptibility to microbial exposure need to make sure that they can control that humidity within the indoor space as best they can. Having a humidity tester is a pretty good way to start. You can have on your air-conditioning systems controllers which, once they sense the humidity getting above 50 per cent, can start the unit working. But you're not going to get the same humidity down in Hobart as you're going to get up the other end, so that's got to be taken into account in how you deal with it.

The Hon. SUSAN CARTER: Would it be possible to have, for example, a whole of New South Wales standard, or we would want to do it within climate zones?

VINCENT NEIL: Probably climate zones, really, because coming from inland originally myself, we would have hot conditions and we didn't have the humidity, whereas on the coast, we have higher humidity, so there is a difference. Controlling it—if you can keep it under 50 per cent, it doesn't matter where you are, you will have less chance of any microbial growth, but that doesn't take into account leaks, plumbing leaks, whatever it is, indoor showers, increasing humidity without having exhaust in some apartments. All of that is on top of what we're talking about.

The Hon. SUSAN CARTER: Sorry, when you say indoor showers, you're saying showers or baths with no external ventilation? Is that what you mean by indoor showers?

VINCENT NEIL: Yes. Sorry, I didn't word that very well. You need to have ventilation.

The Hon. SUSAN CARTER: Can that be an exhaust fan or it should be external ventilation?

VINCENT NEIL: It should be external, because otherwise you're pumping moisture up into the ceiling cavity, which then can produce growth in the ceiling cavity, which for some people who react very badly, that's not a way to go.

The Hon. SUSAN CARTER: Is that an issue that you're suggesting should be considered in terms of building codes, especially in relation to apartments?

VINCENT NEIL: Yes. There should be ventilation exhausting from any wet areas, and that would include laundries. Later buildings now have main air draw from all of the wet areas within a unit, and it's in every unit. Whether it's sufficient or not, that's another kettle of fish.

The Hon. SUSAN CARTER: And when you say external ventilation, would it be sufficient if there was an internal light well in the middle of a building, or it would need to be somewhere where there could be cross-ventilation?

VINCENT NEIL: No, when you pull air out of a unit through ventilation, it will come under doors, going out into foyers, etc, and it will pull from things like car parks. Of course, you've got to be careful, because they can be a source of both CO2 and moisture.

The Hon. SUSAN CARTER: And there would be particulate issues potentially from car parks?

VINCENT NEIL: Yes, carbon monoxide as well as carbon dioxide.

The Hon. SUSAN CARTER: Thank you very much for answering my questions.

The CHAIR: Mr Lark, were there any earlier questions, either to your fellow panellist or yourself, that you'd like to add a contribution to?

DAVID LARK: No, I endorse exactly what was said by Vince. He's handled that extremely well under a fairly difficult set of circumstances. I'd just like to endorse the fact that where you've got moisture, like Mary had a little lamb, they follow each other. Where you've got moisture, you've got mould. If you control the moisture, then there's a very good chance that under most circumstances, you'll not have any problem with mould and other bacteria, and microbial growth will not occur. But the point that really I need to get across and I would like to convey to you is that it's not just the moisture today that's in the building that's concerned.

It's what happened four, five, six or 10 years ago that you've got to even think about. So if the roof leaked or you had a school that had a—one school I went to had five lots of carpet replaced over a period of four or five years for the same leak. They could have fixed the leak; could have solved the problem, saved a lot of money on the carpet and the kids and the staff wouldn't have been exposed. But they didn't control anything; they just basically paid money to have a nice new carpet and didn't have stains on the carpet.

The CHAIR: In an example like that, where the moisture was the cause of the air-quality issue, what are the key levers in terms of intervention to prevent the dampness, in your view?

DAVID LARK: The first intervention that should have happened, if you have a roof leak in any building, I think is the expression is "the first expense is the best expense". Like a school that I did in Victoria, a $5½ million remediation because 169 roof leaks that had occurred in the previous year had been ignored. Every time it rained there was still microbial growth there from before, and you get this ratcheting effect that basically it becomes exponential. The control of what grows initially is easy. It's not easy when it gets to the point where you've got microbial growth of 10 to the 20th in log terms. That's when remediation becomes very difficult and hence the very expensive outlay that had to be put into that school to get it back to usable state over one very busy Christmas break that I had—back in my youth, fortunately.

The CHAIR: Those couple of examples from schools are quite compelling, particularly given the discussion that we've had earlier today about classroom environments. I wonder if on notice you could provide some more information about those particular case studies. They could be de-identified if needed.

DAVID LARK: I would be very happy to share de-identified copies of those reports and the sequelae that went with them. Quite happy.

The CHAIR: Thank you. In your written submission, on page 10, in terms of your recommendations and a path forward, you also made a recommendation around independent verification following remediation of water-damaged buildings. I can't help but think this is going to be more and more common with climate-induced disasters like floods. Could you speak a bit further to that recommendation that you've made? What's the gap that exists and how are you recommending that we address it?

DAVID LARK: The gap is broad. In Australia it's quite common for remediators to be both indoor environmental professionals, assessors, whatever you want to call them, and remediators at the same time. So they put a different shirt on the next day, take the samples, and they send them to be analysed by laboratories like the ones that I've been running all my life. We look at them and we go, "There's nothing there. There's nothing there.

That's clear. That's clear. That's clear." And they possibly haven't even exposed them. It's up to them to remember whether they took them or not. If they've taken them from known clean areas 20 times you wouldn't know.

The CHAIR: If I understand correctly, your central point here is around the independence.

DAVID LARK: It's the same issue that you have with buildings and independent surveyors and people who are going to sign off the building, engineers and so on. That's where we've got to get to. Those people have got to be at arm's length from the people doing the work. I went to an operating theatre once—there was a batch of operating theatres in a well-known town in Queensland. Very humid environments up there, so the air conditioning has to work double time. Before I was to take the sampling I had some time to kill so I had a look around in the ceiling to have a look at the air conditioning and noticed that all the HEPA filters, the filters that protect the client who is having the surgery last, before the air gets to his open knee or whatever he's having done, had been over-badged with a new use-by date. I took the first sticker off and there was another sticker. There were five stickers on the same filter. All the filters were the same. Each time those stickers had been applied, each three-month inspection that happens for operating theatres' filtration systems, they'd just stuck a new sticker on there and dated it another three months time and sent in a bill.

The CHAIR: That's a frightening example. I might come back to my very first question, because I'm not sure if you chose not to answer it or if you didn't hear it.

DAVID LARK: I wasn't hearing anything.

The CHAIR: I'll ask you the first question again, because I understand you're based in New South Wales, but you obviously just gave us an example from a Queensland hospital. If you're working in different jurisdictions, are there other Australian States and Territories or overseas jurisdictions you're aware of that have a better regulatory framework that you think we should be looking at?

DAVID LARK: We have the basis of a good regulatory framework called the AIRAH HVAC Hygiene Guidelines and it's just not being applied. The funds aren't available. The engineers who have the responsibility to put it into action—to action it, audit it, make sure that it happens, to act on outages and so on—the action path; it's just not the inspection. It's being able to follow through and deliver satisfactorily. They just aren't funded enough. Hospitals in New South Wales, Doctor, I think you know, are fairly hard on the cash at the moment, and it's never been any different. Air conditioning when I worked for TVH—before that, it was Enviroair—back 15, 20 years ago, that was in Melbourne, and people were dying from aspergillus in critical care units in the Austin Hospital even then.

The CHAIR: So to your knowledge, there's not another State that has a framework that encourages that to be done more effectively?

DAVID LARK: They're all the same. If you look at the papers as a reflection of mould issues, the Prince Charles Hospital in Brisbane has had problems with aspergillus. Brisbane General has. It gets out and it leaks, but it's only the tip of the iceberg that has been revealed to the press.

The CHAIR: I haven't got any more questions. Are there questions for my colleagues? Before I let you go, were there any particular key points—

The Hon. SUSAN CARTER: I have a follow-up question. When you said in relation to maintenance that the funds aren't available and the engineers aren't able to comply with the AIRAH standards in relation to the regular maintenance of the HVAC systems, what sorts of funds are we talking about—a million dollars a year, a hundred dollars a year? Do you have any estimate as to what we're talking about?

DAVID LARK: It depends on the size of the hospital, of course, but on just a New South Wales-based assessment my understanding is that there are more than 5,000 buildings in NSW Health, of which more than a thousand are air-conditioned—maybe 2,000. On an annual basis it would have to have a budget that would be very substantial for it to be maintained in an appropriate way.

The Hon. SUSAN CARTER: Any sort of ballpark figure that you could offer, understanding it's a rough estimate?

DAVID LARK: No. Ask Mr Eddie Pirillo. He'll have the answer in five seconds.

The CHAIR: Before I let you go, were there any particular key points you wanted to get across that you haven't had the opportunity to speak to?

DAVID LARK: No. Just to go back to what I said, if you control the moisture, you control the mould. All of these buildings that are air-conditioned and have buildings management systems running, they all measure the humidity now. They do nothing with the data.

CORRECTED

VINCENT NEIL: Could I just quickly pop in before we close? Housing NSW, a lot of the houses are now put out to contractors to supply for those who cannot afford rental housing in today's market. The contractors appear to be ensuring there is a profit from what they do, which is what businesses are all about. So instead of maintaining these buildings, when we have a mould outbreak because of a water ingress, instead of removing the contaminated materials they come out with paint brush and paint and paint over it, and people are sick and they don't get better by painting over what's there. We're talking about hospitals, but there's a huge area in Housing NSW.

The CHAIR: That brings us to the end of this session. If there are additional questions from the Committee, the secretariat will be in touch with you with those in writing. I think there was one taken on notice. Thank you very much again for your time today.

(The witnesses withdrew.)

(Short adjournment)

Associate Professor ARIANNA BRAMBILLA, Associate Professor, Sydney School of Architecture, Design and Planning, Centre of Research Excellence in Healthy Housing, affirmed and examined

Professor REBECCA BENTLEY, Director, Centre of Research Excellence in Healthy Housing, before the Committee via videoconference, affirmed and examined

Mrs MERYLESE MERCIECA, Business Manager and Occupational Health Nurse, Blue Eco Homes, before the Committee via videoconference, sworn and examined

The CHAIR: Thank you all so much for making the time to give evidence this afternoon. Would you like to start with a short opening statement?

ARIANNA BRAMBILLA: Honourable members, thank you for welcoming us here today and allowing us to share our perspective with this Committee. The Centre of Research Excellence in Healthy Housing involves Australian and international experts in epidemiology, public health, environmental health, architecture and design as myself, engineering and urban planning. Our research focuses on how housing shapes population health and what we can do to optimise healthy housing in Australia. Everyone has the right to live in a healthy environment, yet not all do. Despite being considered by the United Nations as a fundamental human right, on par with access to fresh water, poor indoor air quality still represents a public health threat.

While indoor air quality encompasses a wide range of factors, many of which you have discussed here today, mould demands particular attention because it is both widespread and driven by multiple interacting factors. Indoor mould places almost four million Australian households at risk of adverse physical and psychological health outcomes and potentially fatal consequences. In the centre, we estimated that over the next two decades, mould will cost Australia over $1.9 billion in health treatment and $4.2 billion of household income loss coming from mould-related health conditions. Evidence shows that mould-related health impacts are disproportionately borne by those already facing higher vulnerability. People who are immunocompromised or managing chronic illness, almost 1.8 million Australians, experience greater physiological risk from mould exposure.

At the same time, residents in social housing and low-SES households are more likely to live in dwellings with persistent damp, inadequate ventilation and limited capacity for remediation. This unequal distribution of exposure underscores that mould is not only an environmental health issue but a matter of social equity. Mould growth is shaped by complex interaction of building- and environmental- and occupant-related factors. Building design, construction quality and material performance determine how moisture is managed. Environmental conditions such as temperature, rainfall and humidity establish the baseline risk, while routine occupant practices influence ventilation, moisture generation and surface drying.

Yet beyond these immediate factors, mould incidence is increasingly exacerbated by systemic issues, such as design and construction defects, rapid changes in building typologies and the unintended consequence of tightening energy-efficient standards that have increased airtightness without parallel improvement in ventilation systems. These trends occur against the backdrop of a changing climate that is amplifying moisture loads across Australia, while limited community awareness about moisture control and healthy ventilation practices restrict the effectiveness of household-level mitigation. Importantly mould is not a problem confined to a particular building type or age. However, despite the magnitude of this problem we still do not have national prevention guidelines for mould in homes. Australia has long relied on international best practices for mould prevention and indoor environmental quality.

However, these standards are based on overseas climates, mould ecology, construction type and materials and building practices that may differ substantially from Australia's. To close the gap between imported solution and on-ground performance here, we need locally generated evidence and Australia-specific guidelines that reflect our unique environmental conditions and housing stock. Further, there is a lack of agreed upon metrics to benchmark what constitutes a healthy indoor environment. At present there is no clear understanding of what level of indoor mould constitutes an acceptable health risk. Existing definitions are largely based on empirical observation of material samples in laboratory settings and fail to provide holistic building-level benchmarks.

Without a holistic approach to the problem, holistic solutions cannot be developed. The Centre of Research Excellence in Healthy Housing advocates for an updated policy framework with local specification about ventilation, air filtration and mandatory routing monitoring, enforcing of mandatory reporting and disclosure of cases of mould in public buildings and social housing, targeted retrofit programs prioritising those homes where vulnerable Australians live, and leadership and investment from the Government to move towards a holistic solution that leaves no-one behind. With 1.2 million extra homes to be built by 2029, the time is right for action to ensure that health risks posed by mould in indoor residential spaces are tackled.

The CHAIR: Are there any additional opening statements from our witnesses online?

REBECCA BENTLEY: No, Arianna is speaking on behalf of the CRE in Healthy Housing and I'm also part of that.

MERYLESE MERCIECA: Thank you Chair and members of the Committee for the opportunity to appear today. My name is Merylese Mercieca. I am co-owner of Blue Eco Homes, a building company focusing on sustainable, high-performance buildings, including Passivhaus homes. We are a member of the Australian Passivhaus Association as well as other industry associations. Before working in the building sector, I spent over 14 years as a respiratory nurse and clinical nurse consultant in Western Sydney, caring for patients with asthma, chronic respiratory disease and other conditions that are often triggered or worsened by the environments people live in. This background really shapes the way Blue Eco Homes look at buildings. For us, indoor air quality isn't just a building issue, it is a preventative health issue.

A key point from our submission is that indoor air quality is largely determined by decisions made when buildings are designed and constructed. The knowledge to deliver healthy indoor environments already exists. Where we seem to fall short in New South Wales is relying on design assumptions rather than verifying how buildings perform once occupied. Through post-occupancy monitoring and our own case study, we've seen that when buildings use airtight construction, controlled ventilation and good moisture management, indoor pollutants can be reduced dramatically, and people can feel the health benefits quite quickly—within days in our case study. So the key message I'd like to share with the Committee is that clean indoor air is achievable today.

The biggest difference can be made through measurable standards, monitoring, particularly in public buildings and social housing and verifying that building systems continue to perform over time, because in reality, you can't manage what you don't measure. The good news is that this is a solvable problem. The building sector already knows how to deliver healthy indoor environments. What is needed now is the policy framework to make sure buildings actually perform the way they are designed to. We believe clean indoor air should be treated as essential public infrastructure, similar to safe water or safe food. Indoor air quality is measurable, it is achievable within the current construction capabilities, and it is capable of delivering rapid health benefits. Thank you and I'm happy to answer any questions.

The CHAIR: I might start with a couple of my own questions before we go to the rest of the Committee. We haven't spent a great deal of time yet talking about residential settings, and a lot of the discussion is focused on public buildings. Both of you have made recommendations around ongoing monitoring, or post-occupancy monitoring, so I'm interested in what you think are the critical things to monitor but also the feasible things to monitor in a residential setting, particularly as opposed to public buildings or commercial buildings. The question was to either or both of you.

ARIANNA BRAMBILLA: I think that there are a number of different factors that can be easily detected in a house. For example, we're speaking about temperature and humidity. It's something that all cheap sensors can do. I was following the discussion on calibrating the sensors. This is just to say that all sensors can actually do that pretty easily and are available to everyone, so it can be deployed at scale. Then there could be CO2 because it's a very good proxy for ventilation rates, for example. Even if we know that it does not correlate directly with mould presence, it is a good indicator of whether the indoor is ventilated enough or not. Probably I would also argue for TVOC as a mandatory parameter to be detected or monitored.

MERYLESE MERCIECA: I would actually verify and agree with that. We routinely monitor carbon dioxide for ventilation adequacy, relative humidity and temperature, which obviously are your indicators for potential mould growth, and we also monitor VOCs and particulate matter, 2.5 particulates and smoke particles for that reason. We just use a fairly accessible small gauge that's quite inconspicuous in the homes, but they can be definitely made at a bigger scale and more accessible.

The CHAIR: I wanted to come to mould. There's been a lot of discussion around mould today. In particular for building standards for residential properties, what are the key aspects of that that you would want to improve if there was an updated regulatory framework? What are the things that aren't being done well or that we should be looking at?

ARIANNA BRAMBILLA: The building construction code of Australia introduces provision against condensation, which is one of the major causes of mould beyond building defects and leakage, of course. In 2019, so the code is pretty young in how it addresses mould requirements. We would probably want to see a growing number of provisions for all buildings, not just the selected building typologies that actually are now in the code and are considered in the code, and also trying to work together with condensation and ventilation. This is what I was referring to before.

If we look at the problem only from one side, we cannot actually address mould, because it's very complex, and that's what's happening when you have high air tightness requirements without appropriate

ventilation rates, because basically you are accumulating moisture indoors, increasing the risk of mould, rather than decreasing it. It needs to be holistically looked at as an issue and as a solution, so it needs to tackle design but also retrofit and maintenance and routine monitoring of air quality within buildings to make sure that mould is not developing, because when you see it, it's basically too late. It means that it's growing within your wall, under the carpet or within the ceiling, and what you can do there is just basically cosmetic cleaning of what is out there. Instead, good renovations would require very expensive treatment or replacement of the materials that are damaged.

MERYLESE MERCIECA: One of the things that we implement with the air tightness—and I agree that it's been partially introduced in the building codes—is we put mandatory ventilation systems in, because occupants don't ventilate their homes nearly as much as they should. The code relies on occupants opening windows far more often than they actually do because, again, when you're talking about extreme heat or extreme cold, obviously they're keeping their windows closed to maintain that indoor temperature. They're not ventilating adequately. We actually put mechanical ventilation in all of our buildings.

ARIANNA BRAMBILLA: If I may add to that, it's not just a matter of awareness; it's also a matter of possibility. In some settings it's not possible to open the windows. I'm thinking about, for example, schools, if you have a lecture going on you can't open the window if it's close to a road because there's noise coming in. Also I'm thinking about social housing where maybe windows actually are not openable or they can't be opened because they haven't been maintained. There are a number of different issues that we cannot rely on people to open windows to keep healthy their indoor environments.

The CHAIR: I wanted to come to you Mrs Mercieca with this case study that you've provided us, which was very interesting. A lot of the discussion we've had is at a very high level and this looks like a very practical example. Could you talk us through this building that you've described in this document?

MERYLESE MERCIECA: Of course. Basically we had a young lady come to us in tears, a history of lots of respiratory illness, chronic cough, chronic medication use, headaches. She was living in a code-compliant apartment. We had a Passivhaus certified display home that we'd been using, which was around about the same age as the apartment. What we were able to do is actually put monitors in both buildings and monitor the indoor air quality in both while she was in the Western Sydney apartment. Then we actually moved her into the Passivhaus for a month, where we were able to keep monitoring both her empty apartment and the Passivhaus. Within four days she was not requiring medication every day for her cough and her headaches. What we found was over the course of that month she progressively got better and was requiring less and less medication. She was reasonably healthy by the time she went back to her own apartment and it only took about three days before she was back needing medication in her code-compliant apartment.

The CHAIR: Can you explain to us what the key differences were in terms of the construction or design of that Passivhaus? What made it different?

MERYLESE MERCIECA: Passivhaus has all of those components that we were talking about. It has airtight construction. It has a mechanical ventilation system, it actually filters the air, it takes out the humidity or keeps the humidity in a proper range. We use low-VOC materials. It was all electric, so there was no gas in the Passivhaus, compared to her code-compliant apartment, which was a standard apartment, gas cooktop and basically had the requirement to open windows for ventilation.

The Hon. SUSAN CARTER: Thank you very much everybody for being here today. I understand that you've said that you think that commonly available carbon dioxide monitors are a good proxy for measuring air quality, along with measuring humidity and VOCs. Is there an easily accessible way to measure VOCs?

MERYLESE MERCIECA: Yes, you can get monitors that actually monitor all of those things in one go.

The Hon. SUSAN CARTER: How difficult or easy are they to use?

MERYLESE MERCIECA: They literally just sit in the corner of the room. They have an app; you can download whenever you like what the reading is. There are more complicated ones which can get wired into buildings, but I've not had as much experience with those.

The Hon. SUSAN CARTER: How often would they need to be recalibrated?

MERYLESE MERCIECA: Not all that often.

The Hon. SUSAN CARTER: That's six months? Five years?

MERYLESE MERCIECA: I'd say we do ours probably 12-monthly.

The Hon. SUSAN CARTER: And you can recalibrate yourself?

MERYLESE MERCIECA: Yes, it's basically a matter of resetting. Ours are a very basic kind of model that we use.

The Hon. SUSAN CARTER: And they include a humidity monitor as well?

MERYLESE MERCIECA: Yes, it does carbon dioxide, humidity, temperature, particulate matter, VOCs, nitrogen dioxide, ozone and carbon monoxide.

The Hon. SUSAN CARTER: The advice we had from witnesses earlier was essentially that if carbon dioxide levels become excessive, you need to leave that room. What's the protocol for excess humidity?

MERYLESE MERCIECA: Good question. What we use is air-conditioning units that have dehumidifiers in them. Generally, it'll be affected by nature a bit, obviously, if outside it's raining. But if it's a nice day, open up the windows and dry it out that way.

The Hon. SUSAN CARTER: In terms of maintenance of air-conditioning units—this is an issue that we've also taken evidence about—are there standard protocols? Can you clean the air conditioner yourself? Do you need to get somebody in a residential setting to come in and do that? If so, who do you get and how often?

MERYLESE MERCIECA: We have people come in. That's something we do. A lot of times, it's as simple as changing filters, depending on the complexity of the air conditioner, I would guess. We also have the HRV, the heat recovery ventilation system, which also requires changing of the filter, depending on the level of pollution and things that it's picking up, about six-monthly as well. You would probably do the air conditioner and the HRV at the same time.

The Hon. SUSAN CARTER: We heard evidence this morning that simply attending to filters may be insufficient—that you need to check the whole system. You might need to clean the coils. You might need to look at the ducting. That was in the context of a larger scale installation in a public building. Would that also be true for a home, a residential setting?

MERYLESE MERCIECA: We don't tend to. I think that would become more of an issue if there was mould present, because the mould can get into the system.

The Hon. SUSAN CARTER: Isn't part of the reason for maintaining the duct work and everything to prevent mould getting into the system?

MERYLESE MERCIECA: Our HRV system is what prevents mould getting into the system.

The Hon. SUSAN CARTER: Sorry, what's an HRV system?

MERYLESE MERCIECA: The heat recovery ventilation system.

The Hon. SUSAN CARTER: Sorry, I don't understand what that means.

MERYLESE MERCIECA: The heat recovery ventilation system, it's the mechanical ventilation that we use. It basically filters the air 24/7. It actually maintains the humidity. It will actually adjust the humidity.

The Hon. SUSAN CARTER: What's its relationship to heat?

MERYLESE MERCIECA: Say in winter when you're heating up your building, it exports the air out.

The Hon. SUSAN CARTER: Is that like a heat pump?

MERYLESE MERCIECA: A heat pump's more to do with water and heating. This is much more about basically keeping the energy that the house has created so you don't lose the heat.

The Hon. SUSAN CARTER: How does that clean the air conditioner?

MERYLESE MERCIECA: It's the filtering part. The heat part is not the part that does it; it's the filtering part.

The Hon. SUSAN CARTER: But does it clean the duct work?

MERYLESE MERCIECA: No, it doesn't need to, because it's actually stopped the particles coming in in the first place, and it's filtering the air, so you don't actually have the—

The Hon. SUSAN CARTER: We heard evidence that damp could lead to fungus, which could lead to mould.

MERYLESE MERCIECA: That's correct. With this system, you don't actually have that damp, because it actually manages the dampness within the air.

The Hon. SUSAN CARTER: Is that capable of use on a larger building like a school, for example?

MERYLESE MERCIECA: Absolutely. It's designed for each building. Basically there are exhaust ducts, so there's intake air and export air. That's just designed based on the building, so it doesn't really matter what the building is.

The Hon. SUSAN CARTER: For these systems to work, do you need double glazing, or do they work with single-pane windows?

MERYLESE MERCIECA: It's basically a holistic approach, so it'd be better to have double-glazing windows because if you've got single glazing you have got cold air coming through those gaps in those windows. It would work better as a whole system. But it would certainly improve a not so good setting.

The Hon. SUSAN CARTER: Is it possible to retrofit this system into an existing structure?

MERYLESE MERCIECA: Yes.

The Hon. SUSAN CARTER: What exactly would need to be retrofitted and what sort of cost are we looking at?

MERYLESE MERCIECA: I think that would be dependent a lot on the building itself and the size of the system. You'd require the system itself, ducting to each room, so I guess accessibility to be able to put the ducting in would be a little bit of a limitation in some cases.

The Hon. SUSAN CARTER: Would that work in an apartment building where there wouldn't be cavity space between floors?

MERYLESE MERCIECA: It depends, because there's quite often cavity space for the other services, so it just depends on how much room there would be in there. It might include adding bulkheads into the apartments.

The Hon. SUSAN CARTER: But you'd need sufficiently high ceilings in the apartment before you could start lowering them with bulkheads, wouldn't you?

MERYLESE MERCIECA: Not really, because it's not a really big duct. It's not as big as an air-conditioning duct, for example. I believe 65 mil.

The Hon. SUSAN CARTER: Sorry, I understood that you were talking about air conditioning and an HRV installed together. So you would need an air-conditioning duct, wouldn't you?

MERYLESE MERCIECA: Not necessarily, because you can have HRV without air conditioning.

The Hon. SUSAN CARTER: What would control the humidity then?

MERYLESE MERCIECA: The HRV.

The Hon. SUSAN CARTER: And that would control ventilation?

MERYLESE MERCIECA: Yes, correct.

The Hon. SUSAN CARTER: But it wouldn't provide any cooling.

MERYLESE MERCIECA: But it wouldn't provide cooling in that case, no. You'd need to look at ceiling fans or something that way instead.

The Hon. SUSAN CARTER: Thank you. That's really interesting.

The CHAIR: Just one from me, and then I'll come to Mr Donnelly. Coming back to the healthy housing centre, there's been a lot of questions around cost. Is there research that you can point us to in terms of the cost-effectiveness of some of the interventions that we've been talking about?

ARIANNA BRAMBILLA: The centre has done some costs, not in terms of financial costs but really the indirect cost of improving the mould situation—what we submitted, for example, is around 4,190, the adjusted life years if we were to reduce mould in homes—or the costing estimated in savings on the health sector for treating cases of mould, or household income that comes from being able to actually work instead of being at home with health-related issues.

The CHAIR: I'd be fine for you to take it on notice, but are you able to provide those pieces of research to the Committee?

ARIANNA BRAMBILLA: I think Bec—

REBECCA BENTLEY: Just to confirm, we haven't actually modelled, for example, an intervention A, how much would that make a difference to that overall envelope of effect that we've estimated, which is what Arianna read out, but we're absolutely happy to provide all the background material on how we've made those estimates.

The Hon. GREG DONNELLY: Thank you for appearing today to provide us with an opportunity to ask some questions in addition to the submissions, which are very helpful. Is it too simplistic to suggest that in looking at this overall situation of trying to lift the quality of air inside buildings, we've effectively got a dichotomy of the existing stock of buildings? In other words, close your eyes and think of every building in Australia as an existing stock, and that's one group, which is an extraordinarily large number of buildings, in all the configurations that you can imagine, and then you've got what is looking into the future, and that is the buildings which are not yet built, which are subject to existing codes, and those codes that might change over time. So you've got two categories, essentially.

In terms of concentrating effort—and I'm not wanting to express a moral judgment about this of being good or bad but just the reality of it—dealing with the existing stock of buildings is a huge prospect, just even to contemplate it. Is that really where we should be pouring our efforts or whether or not there's an argument that really that's good to be able to do but it only could be essentially done on a niche basis, not on scale, and what we should be really doing is concentrating all our energies on what's to follow—in other words, improving the codes, if we can get them moving as quickly as we can, by having a consolidated amount of energy to push that. That's really what we should be doing?

ARIANNA BRAMBILLA: One should not exclude the other, ideally, right? I would argue that if we only focus on new buildings, we just leave behind a huge part of populations, and that's maybe the part of the population that cannot afford a new building, a new apartment, a new house. It circles back to the equity issue. We should allow or we should help everyone. We should allow everyone to live in a healthier space. If we need to look at where the efforts would be best placed, it's probably to look into the existing stock, because there are many buildings that are ageing, and we need to make sure that we start with what we have and start to help people that are living in buildings that are not suitable at this moment to actually accommodate.

The Hon. GREG DONNELLY: Yes, to that standard that we would hope is a minimum that everyone should be able to live with and live under.

ARIANNA BRAMBILLA: Yes.

The Hon. GREG DONNELLY: Which leads me to the next question. Taking a property, a block of flats four or five storeys high in any suburb of Sydney, what is the job involved in essentially conducting the most thorough audit that is necessary to be able to make assessments of what needs to be done to a four-storey block of units? I'm trying to comprehend. It seems to me there are so many elements to it all that that job in and of itself, that threshold job of establishing what requires to be done, is a very big task.

ARIANNA BRAMBILLA: If you have to think about the most thorough assessment that we could do, we would probably need to look into what's the indoor environment at the moment, monitoring, for—we would say that the minimum for the most thorough job would be one year, so that you get all the seasons possible. Monitoring everything that is happening in terms, as we were saying, of temperature, humidity, VOC, PM2.5, PM10 probably, and CO2, but also looking at monitoring what people are doing inside, because that's also important, and looking at construction and design documentation to see how the building was built, what's inside the wall and what's the basic accurate thermal performance of that building, which is clearly a huge job. Probably setting up some benchmark for having an idea of how we can approach that without all of that work would be something that could help. But if you have to look at what you would do in terms of the most thorough job that you need to do, you have to look at everything. So from before the building was built—construction and documentation, basically—and during the life of the building, what happened inside and outside, and within the walls as well.

The Hon. GREG DONNELLY: I'm trying to work out whether or not—and I don't use the word in the strict sense of taking a shortcut—but to do that thorough audit with all those elemental parts, just say for a four-storey block, it would strike me it could cost perhaps millions of dollars or many hundreds of thousands of dollars to do that thorough audit. I don't presume you're putting the case forward that you should do anything less than the most thorough audit. There's not an argument, surely, that this is the blue-sky standard or the platinum standard, but we can do the silver or the bronze and that will get us at least part of the way there. That's not the argument, is it? This all comes down to cost. I don't want to be so crude about it, but someone's got to pay for it. Someone, somehow. We can work out how that should be done from different points of view, but I'm wondering

if the audit is so expensive to find out what is really the ideal to be achieved, if we can, that is almost unachievable, isn't it, to be that aspirational?

MERYLESE MERCIECA: I agree. Obviously that would be the ideal, to do the high level. With our case study, we actually used a building biologist who came in and did indoor air samplings and actually looked at the issues that might be causing the results he was getting. That would be far less expensive than what we're talking about.

The Hon. GREG DONNELLY: How far does that get us down the line in terms of moving to a building with better ventilation? In other words—and this is not a criticism—you would argue that was found to have a utility about it, there was efficacy. It would have had a better cost curve in terms of the overall cost to do it. You found that quite satisfactory to move the standard up from where it was to something that was better?

MERYLESE MERCIECA: Yes, I think so, because he was able to give us mould readings. He was able to give us all of those things that gave us something to work with.

The Hon. GREG DONNELLY: What I'm trying to grasp is that to ultimately move things en masse at scale not always but often requires legislation or regulation. If it's just an option or a choice left to the market it doesn't generally move very rapidly. I'm thinking in trying to move it, if this is the desired position, to a higher standard what becomes the minima we're trying to set and saying, "This is not the platinum standard." Maybe it's a bit too crude to say, "This is not the highest standard achievable possible, but this is something that is worthwhile aspiring to because it's going to lift the standard to a better position than it's in." And how do you define that?

ARIANNA BRAMBILLA: I think what I'm trying to say is that the most thorough audit clearly is too expensive. It is something that would require also a lot of time and effort and, as we said, cost. But there are models that we could actually employ to make sure that there are a set of interventions that can be done in an effective way without the thorough audit. Effectively, what I'm trying to say is that it is possible to—I don't want to say simplify because that's not the right word—but to assume things when we know, for example, as the other witness was saying, the microbiology within the home. If we know where the mould is, what type of mould it is, or we also just have a look, feeling the room, it is possible to assume some of the others parameters to make possible making assumptions and strategies that are effective to increase the health indoors.

The CHAIR: Just in the last few minutes we've got, were there other key points that you wanted to have the opportunity to speak to that we haven't asked about?

ARIANNA BRAMBILLA: I think from my side, everything that is in our submission and the opening statement is what we would like to bring forward today.

REBECCA BENTLEY: Just emphasising from the point of view of population health the point Arianna made about prevention, actually nipping some of these problems in the bud or addressing things early is probably more cost effective and from the point of view of the health of occupants a better way to go. Just a sort of guiding principle on this as well, thinking about this in a prevention framework, would be something I'd strongly advocate for.

The Hon. GREG DONNELLY: We've had the great fortune with this inquiry to have experts like yourselves come along, and many others, all with essentially the same objective. Once again, it's not always government, but often it is in terms of providing frameworks, legislative and regulatory, to provide that momentum for movement to higher and better standards that we've seen in so many areas over time. Are there any thoughts about what could be done that's not being done to nudge governments at a local but particularly a State, Territory and Commonwealth level to accelerate or move this understanding along at a better clip in terms of understanding the importance of improving air quality inside buildings?

ARIANNA BRAMBILLA: I think that messaging is very important. The way we speak about indoor air quality or mould, it needs to be related to everything that we are discussing here today and everything that you have heard in this inquiry, so it's not just about temperature, comfort or just living inside a building that is a bit mouldy, but it's a real health threat. There are people behind it. There is the health of a number of Australians that are affected by that. I think that the clear message on the threat of poor indoor air quality must be better tackled. We always refer to mould as the next asbestos, so something like we did for asbestos. Everyone was aware that that was a problem. We needed to actually do something. That's, for example, something that we would argue for—a clear message on the health threat of mould, to make mould seen not just as something cosmetic that affects our building, and then you wash your clothes or your shoes that got mouldy during the last rainy period and that's done, but it's effectively a symptom of something bigger and potentially much more harmful that is happening within your house.

MERYLESE MERCIECA: I'd like to suggest if you were interested, you are more than welcome to come and look at one of our homes and see what it is that makes up that holistic approach, if that would be of benefit.

The CHAIR: Thank you. That's very generous. That brings us to the end of this session. There were a couple of things taken on notice, and if there are supplementary questions the secretariat will be in contact about those as well. Thank you so much again for your time today.

(The witnesses withdrew.)

Mr MARK VENDER, Advocacy and Policy Manager, Australian Institute of Refrigeration, Air-conditioning and Heating, affirmed and examined

Dr CLAIRE BIRD, Associate Director AIRAH IAQ Special Technical Group, Australian Institute of Refrigeration, Air-conditioning and Heating, affirmed and examined

The CHAIR: Thank you so much for making the time to give evidence today. This is our last session for the day. Would you like to start by making a short opening statement?

MARK VENDER: Thank you for the opportunity to present evidence today. We applaud the Committee for leading the way on an issue that is vital not just in New South Wales but everywhere—indoor air quality. I'm here alongside Dr Claire Bird on behalf of AIRAH, the Australian Institute of Refrigeration, Air Conditioning and Heating. I lead the advocacy work for our organisation, and Dr Bird leads AIRAH's diverse indoor air quality special technical group, with specialists across most aspects of indoor air quality. AIRAH has been operating since 1920. Our members traditionally design, commission, install and maintain the systems that keep our indoor spaces comfortable. Nowadays, we are called upon to also provide safer environments, and our membership has expanded. In addition to our traditional members, like mechanical engineers and air conditioning and refrigeration technicians, we also have members across filtration and air purification, building physics, occupational hygiene, equipment manufacturing, commercial laboratories and academic research.

Building on our submission to the Committee, and also acknowledging that you've now been in these hearings for a couple of days and heard a lot from lots of different stakeholders, what we wanted to do in this opening address was just put forward three recommendations, really. First of all, we call on the New South Wales Government to show leadership in making indoor air quality a priority. We strongly support the Burnet Institute's recommendation to develop an indoor air-quality strategy across various government departments with a clear leader and also a ministerial advisory council comprising experts from different disciplines. As we noted in our submission, and as you would have heard in the first hearing, indoor air crosses many government departments and professional disciplines.

Secondly, we support the calls for measuring of indoor air quality. To do this, we suggest using a reliable, trusted and consistent measurement framework. AIRAH recommends the New South Wales Government support a NABERS indoor air-quality rating system. NABERS, as you probably know, is now internationally recognised for its success and really had its roots here in New South Wales, with support from the New South Wales Government. By developing a NABERS IAQ tool, we would be linking indoor air quality to an ecosystem that is already used, trusted and built into legislation, leveraging the current infrastructure. Importantly NABERS also allows us to integrate an indoor air-quality rating with other important aspects of building performance, such as energy use. It's vital that our approach to this issue considers indoor air quality, sustainability and the realities of the market.

Finally, we recommend education about indoor air quality. Engagement with building occupants is essential for the uptake of any interventions to improve indoor air quality. By bringing people along on the journey, we will build a genuine understanding of why indoor air quality is so important and also boost our chances of seizing this huge opportunity. Education also includes training our specialists to ensure they have the right skills and that we learn from best practice standards and developments around the world. We would be very happy to take any questions that you've got.

The CHAIR: My question is probably for Dr Bird, because it's a fairly technical one. There's obviously a huge volume of existing standards as well as frameworks and guidelines, some of which are mandatory, some of which are voluntary. It's taken the Committee a lot of effort to try and get ourselves across the complexity of that framework in a short space of time. In your opinion, are there particular standards that you either see as best practice or that have done well in other jurisdictions that we should be prioritising?

CLAIRE BIRD: I'm of the opinion at the moment that most of the disparity between jurisdictions in terms of implementation of good practice is highly variable, and sometimes it's not necessarily just the framework itself but its adherence to frameworks. Obviously, if we look at, for example, an investment in research, again, at the moment, some of that is being State driven, but I think anywhere where we have practised—and I think we would probably look to our own members to find out whether those people that are on the ground and actually looking at those buildings are seeing success in that implementation of those frameworks. I think it's, as you say, such a big field that maybe it would be useful to actually take on notice a report on those different frameworks and for AIRAH to give some guidance to the Committee on how we see those best implemented.

The CHAIR: You're welcome to take that in part on notice so that you can consult with your members. In particular, one of our witnesses this morning felt very strongly about the Australian Standard 1668.2 in schools

that at the moment is an optional alternative to the natural ventilation standard. I'm interested from a technical or industry perspective in terms of the feasibility, acceptance, cost effectiveness of that standard, in particular, in schools. If that can be part of the questions you put to your members, that would be really appreciated.

CLAIRE BIRD: It certainly will be, and it's very critical, because schools are such a unique setting, as we've heard, and again, I'd like to come back with the actual figure, but most of our schools are still relying on split-system air conditioners. The big push to keep the classroom thermally comfortable, because that's how children learn best, obviously then has an impact on the effectiveness of those split systems. I would like to, if I may, pick up on the previous submission that we've just heard testimony for where we were talking about where most of the problems are in buildings. We've heard as well a lot about air conditioners, and that's our specialism here at AIRAH, but certainly split-system air conditioners are a significant issue. We do see cases where they will be cleaned and very quickly. They're becoming popular because that's what they're designed to do. Anything that takes moisture out of the air and protects the building then has the tendency to propagate microbial growth on the surface where that moisture is being extracted.

My actual profession is a microbial ecologist, particularly in buildings, so we're very familiar with this at a professional level as well. We also need to consider the shifting climate. If we're handling more moisture, that makes a difference. If we're in different parts of the country, that makes a difference to how effective any types of frameworks are going to be, because what we put in place for Canberra may not work in Cairns: different building types, different climates and so forth. I do think that there is an imperative for looking at that particular standard as an option for schools, but it often falls short, as do our building codes, in terms of openable windows and abilities to ventilate. That said, even where we feel our members do speak to us, is around what happens when a window is opened but the building is actually carefully balanced for that not to happen. If you've got an apartment under positive pressure, when you open a window, you can make things worse. So understanding how buildings should operate is complex. Those frameworks, like these standards, need to work alongside that, specifically for Australia.

MARK VENDER: I might add on that I guess you probably heard this morning there's an issue there around the way that the standards are called up in the code. So 1668.2 mechanical ventilation—the code also allows for natural ventilation in certain settings. I guess some of our members looked at that as a kind of loophole. So as long as you've got 5 per cent of floor area openable windows and doors, you're kind of good to go, and you can have your split system. That's actually almost been suggested in some jurisdictions as the right approach for spaces like schools. Then we end up in situations where we're not getting ventilation at all, especially if it's cold or hot outside.

One way of changing that would be to make a change to the building code and take that—let's call it a loophole—out for certain building classes. That could certainly be a way of doing it. Whenever there is a proposal for change to the building code we'll go through a process where you do need to provide a kind of cost-benefit analysis. As you've also seen in these hearings, that kind of cost-benefit analysis is extremely complicated in a topic like indoor air quality, which has huge health implications and lots of other productivity implications and all that kind of thing. Yes, most definitely there's a strong feeling within our membership that there's an opportunity there to close that loophole, especially in certain building typologies. Schools are really a classic one, yes.

The CHAIR: I think I can speak on behalf of the Committee to say that there's been a particular interest in schools and hospital settings in part because they're in the direct control of the State Government as well.

MARK VENDER: You also heard from Burnet about the work that they've been doing in the Pathway to Clean Indoor Air in Victoria, where they are retrofitting some schools. The great thing is it's a fairly standard typology, right? We know what a classroom looks like in most cases, and there may be a fairly straightforward solution that could be used in lots of different schools. They'd have more information on the costs and the effects.

The CHAIR: Mrs Carter asked a question earlier today about practicality and cost of retrofitting germicidal UV. I wonder if you're the most appropriate witness to ask that question, or if you need to take that to your membership.

MARK VENDER: Do you want to go for that one?

CLAIRE BIRD: To be honest, I wouldn't have a feeling for the cost of that. I would have to take that to the membership. In terms of effectiveness, I would like to address that if I may. Germicidal UV has been established and been in the industry for a very long time. It tends to be used in air-conditioning systems to try to reduce microbial proliferation on cooling coils. Where it has line of sight it's very effective. Where that light can't shine because there's a component in the way then that limits it, but it nonetheless is very well established as a

technology. That's the type of UV that goes within your air-conditioning system. It is an upper-room system. You can't have it shining on the people in the room.

More recently there have been products coming onto the market which are called PHI UV, which has a much higher energy and therefore is potentially able to have a greater impact on pathogens. It is actually reportedly safe for hitting the skin because it doesn't do the damage that the germicidal UV that's traditionally in the air-conditioning systems on the roof does. Just so the Committee can understand there are some differing technologies out there—some are more established, some are newer. Again, if you wanted to understand effectiveness, that's something that we could look at providing to you in more detail.

The CHAIR: I think we had a discussion earlier today as well about the ducted UV which, if I recall correctly, is what we've got here at the Parliament. Are there questions from my colleagues? Mrs Suvaal, go ahead.

The Hon. EMILY SUVAAL: Thank you to you both for appearing and for your submission. I wondered if I could ask a question I asked one of the previous witnesses around HVAC hygiene guidelines. Within their submission they suggested the legislation of mandatory HVAC hygiene maintenance schedules, either aligned with Australian standard 3666.2 and the AIRAH HVAC hygiene guidelines. On notice could you perhaps provide the Committee with those guidelines. They may well be publicly available; they probably are. Could you just explain to the Committee in really brief terms what those guidelines involve? Dr Bird, your earlier statement was around there being guidelines and frameworks in existence but the issue is actually the adherence to those. So how could we possibly look at those two things?

CLAIRE BIRD: Bringing you back to our indoor air-quality special technical group, we're actually in the process at the moment of finalising an updated draft version of the HVAC hygiene guidelines. The standard you referred to, the 3666, that requires inspection of air-conditioning systems at a visual level.

The Hon. EMILY SUVAAL: Visual, yes, we touched on it previously.

CLAIRE BIRD: Obviously if you've got very serious contamination, that's visible. But what we have to remember is the reason why microorganisms are called micro is because you can't see them without the microscope or doing something with them to make them visible. So we definitely need something that's better than that. At least when we have cleaned a system, at the point at which we walk away from that system we can show that it's hygienically clean rather than visually clean. The guidelines are there for best practice rather than minimum requirement. With 62.1 as well, the ASHRAE standard, and with the redevelopments of 1668.2, we are looking at how those do intersect with each other so that the guideline does dovetail into those standards.

The Hon. EMILY SUVAAL: You mentioned the ASHRAE standard a couple of times in your submission, are you able to just detail for us very quickly what that is?

CLAIRE BIRD: Again I will refer to Mark to talk about the differences between the two standards.

MARK VENDER: The one that we referred to was probably 241, which is the—

The Hon. EMILY SUVAAL: Yes, that's what's referenced in the document.

CLAIRE BIRD: Yes, infection control.

MARK VENDER: Infectious diseases, yes. Before we go on to that it's probably worth mentioning we talked about 3666 very quickly, which sort of says "clean as required" but doesn't really go into a lot of detail on what that means. That's sort of where the HVAC hygiene guideline came from. We saw that was a requirement and put that in place. I believe that 3666 is actually called up in the New South Wales health regulations, but it's not really enforced. That would be something we would advocate for, looking at how can it be enforced, because it does require the inspection and cleaning. Yes, 241 is more about infectious aerosols and what to do in pandemic situations. It recommends some measures that can be taken at periods where there's high infectivity and what can be done in building systems to either increase the outdoor air rates or effective outdoor air rates. if you're using other technology such as UV or cleaning technologies or, alternatively, to reduce occupancy rates. That's another approach you can use to make sure you're looking after your occupants.

CLAIRE BIRD: I'd just like to add that the actual process for the development of the ASHRAE 241 standard in the US was a call from the White House to produce a standard within six months to allow buildings to operate by bringing in supplemental technology such as air filtration devices and germicidal ultraviolet light, which we just discussed, as a mechanism to achieve the equivalent clean air that you would have by bringing in all this external air. The beauty of it is that they came up with a mechanism for moving a standard very quickly. I feel that with evolving knowledge—we just heard from the University of Melbourne. I'm actually a part of some of the work they're doing, where we will be producing data and we want things to happen that are going to quickly allow things to change. I think that mechanism may be useful for government to look at in terms of being able to

get things into practice more quickly. Like you were saying earlier, Mr Donnelly, we really want to have something that we're not trying to shoot up here, but we can achieve. I think having those smart goals is something we could do through that type of mechanism.

The Hon. EMILY SUVAAL: I noted in your submission you addressed the issue of humidity, in particular at part (e) where you talk about the terms of reference may be missing a vital element in terms of the impact of climate-driven changes in indoor environmental conditions on non-pandemic-related diseases. It's something we touched on a bit earlier today, about the need for sort of optimal humidity between, I think, 40 and 60 per cent, a previous witness said, if you agree with those parameters. I just invite you to perhaps let the Committee know a bit further about why these risks also need to be managed and how they are best managed.

CLAIRE BIRD: Absolutely. Humidity in the occupied space affects several tiers of indoor air-quality risks. Very high humidity in the occupied space results in the surfaces becoming sufficiently moist to allow these microbes to grow. It's very good to dispel the myth at this point that you have to have condensation. You don't. The surface humidity just needs to get to a level where those organisms can get the water from the air. That's something that is a bit of a misconception. As long as we're in that 40 to 60 per cent zone, which is what we're targeting for human thermal comfort, we're actually mitigating a lot of the risk around not only mould but infection as well, because when humidity becomes too low it actually dries out mucous membranes and that can make you more likely to spread a transmissible disease through your building.

So humidity we almost see as its own contaminant in our world. Especially when we're managing humidity through HVAC systems, what we have to also remember is for every unit of moisture that we take out of the air we've added it to a surface, whether that be a cooling coil, a cooling tower—we've seen outbreaks of legionella diseases. We've seen problems during construction when these surfaces become exposed. When you get microbes growing on cooling coils and those sorts of surfaces, it's not just mould; the other thing that happens is you get development of these things called biofilms. These are entire microbial communities that start to speak to each other and transfer really important things like antimicrobial resistance genes.

We know from the World Health Organization, who have identified key bacterial and fungal pathogens of concern, that the development of these new pathogens is something we need to be guarding ourselves against. So, yes, moisture control is really vital at all the components in our system. Certainly there are members in AIRAH looking at ways of managing this through what we call pre-conditioning of air. Rather than the moisture being taken out in one step, it can be taken out in more than one step, so no one particular set of coils reaches a threshold where there's a problem. Also we do see this as an association as a core objective for us. For this reason we were actually doing work in that area, where we're actually preparing some workshops and so on so that people can be educated.

My final thought on this is communication is not quite the same as education. Communication to the public doesn't require them to be educated. Educating requires us to become capable of communicating to them. I think when we're talking about not trying to get up and do something manageable, let's try and give people the basic tools they need to prevent moisture in their systems. If I may just share one case study with you, this is from the profession and not from within AIRAH, but I think it's a vital share. Many years ago I was examining some properties in the south of Brisbane. Brand-new apartments, four months old. Numerous people had lost everything they'd got to mould. It was crazy. It was in the underside of their bed mattresses.

It was horrific. One particular lady, her child had been at home for three months and couldn't go to school. These are very serious health impacts. What had happened was the way that the buildings were designed is the extractor fans in the bathrooms, they worked as long as the door was open but as soon as you closed the door there was nowhere for air to come in and make up that vacuum. Consequently, nothing happened. The moisture didn't go anywhere, it went straight into the bedrooms and the other rooms. On the wall was a beautiful little panel that said, "When you're using the shower, please press this button", which supercharges the extraction system but nobody told any of the people who purchased these apartments that was there or how to use it. These are all parts of the equation that we need to think about when we're educating and communicating.

The Hon. EMILY SUVAAL: In terms of the current frameworks that are in place, or standards or otherwise, as they relate to humidity specifically, are there gaps and deficiencies there?

CLAIRE BIRD: Definitely.

The Hon. EMILY SUVAAL: Is there anything you can suggest to the Committee that we should look at or—

CLAIRE BIRD: Absolutely. Look to ASHRAE standard 62.1, which is the American standard. That standard actually sets what we call a dew-point temperature. If you have the right dew-point temperature—the lower the dew-point temperature, the cooler the air is before moisture starts to condense. What you want is you

need to keep it at a level so that you're never reaching that critical number for microorganisms to grow. There are international standards, and I think that one of the things that AIRAH is pushing for is to see that actually incorporated into Australian standards. Mark, would you like to pick up on that?

MARK VENDER: Yes, just to say that I think that's where it would sit. It's probably in that Australian standard space to say—

The Hon. EMILY SUVAAL: Is it not covered there at all?

MARK VENDER: No, humidity is not. Even, actually, thermal comfort is not. It's not a standard. It's something that gets built into—when someone's building a building, that's the expectation, right? But humidity is something that we are working on at the moment and looking at if it were incorporated into a standard, where would it be incorporated, and then see if we can get that process going. I guess your question is: Could New South Wales do something separately on that point? I'm not sure, sorry.

The Hon. EMILY SUVAAL: It's very topical; very interesting. Just a final question from me. You recommend in your submission treating health care as its own indoor air-quality category. I just wanted to get your thoughts. If you could let the Committee know a bit about why that's the case and what you would suggest for that category, specifically?

CLAIRE BIRD: My thoughts on that are that when we're in a hospital setting people are obviously at their most vulnerable. But I was very surprised to hear recently of a conversation where somebody who manages a hospital pointed out that the people that are brought in to manage infrastructure are not always—they come from these diverse backgrounds. This happens across all of our sectors around much of indoor air quality. Outside of asbestos, which is regulated, outside of cooling towers, which have their own guidelines, standards and regulations, we just have such a diverse mixture of professionals servicing the same job and doing the same thing, and yet the quality of provision of that service is very diverse too. I think that's something that's really worth raising to this Committee. If there is something we would recommend, it's defining minimum practice and best practice and working out when you need minimum practice and when you need best practice and knowing where to go to find it. I just think that's a really critical component of this.

The CHAIR: I ask a follow-up question in terms of specific settings. I was quite interested in your written submission that you brought up public transport which, of course, is also within State Government control, and not many other people have raised it. Have you got particular recommendations in terms of what we should be thinking about or considering for public transport settings?

CLAIRE BIRD: Absolutely. I would direct you to—and I'm happy to take this on notice—another organisation I actually do a lot of work with. It's an international organisation of scientists. Several of the people you've seen here who have given testimony are part of that group. We did some work some time ago where we got international experts together on transportation. I'm very happy to share that link with you. They could give you much better advice than I could. Certainly, clearly, that is a key area for us, from all of the indoor air-quality aspects. I would speak to Mark as well—AIRAH members. Who would you say we have that we could point to, to look at transportation and provide advice?

MARK VENDER: I think we can prepare something on notice. Off the top of my head, they're names for us but, yes, for sure. It is a setting where we know there's going to be a lot of crowding; the systems can't always cope with it. There's a lot of near field transmission as well, so there are opportunities there.

The CHAIR: We'd appreciate any information you can provide on notice. That would be great.

CLAIRE BIRD: Certainly that is somewhere where ventilation starts to become very important, and if there are mechanisms that we can find to ventilate those spaces. If you look at the four Ds—distance, duration, density and dilution—as four mechanisms for reducing exposure to airborne pathogens, in that situation you're not going to be able to change how long you stay on a bus for, how close you are to the person next to you, or how many people are standing up in a train, so your only option is dilution. That is somewhere where a combination of ventilation and filtration technologies and potentially some type of UV treatment could become very powerful in reducing that risk.

The CHAIR: Absolutely. I can imagine it would be a very challenging space to get right, with very fluctuant occupancy and also potentially contaminated outdoor air—for example, a bus or a train inside a tunnel. So I'm very interested in that expert advice, if you can put us in touch with someone who can advise us on that.

CLAIRE BIRD: Very happy to reach out to members.

MARK VENDER: I guess we also have heard—and this is from other stakeholders as well, not just our members—in that education setting that we've got these school excursions and things, and the school bus. Getting

on the bus is one of those areas where there's a lot of concern. There are also examples of where schools are just relying on the technology, assuming that the claims of the manufacturer are completely valid. It is a space where we find there are emerging technologies that we sort of can't guarantee if they're actually effective or not that are being installed sometimes. It's just an area where it would be good to have some really solid and trusted guidance on how to improve indoor air quality.

The Hon. SUSAN CARTER: What are some examples of the emerging technologies that you're not satisfied have been fully tested yet?

MARK VENDER: I think especially around COVID times, there was a real boom in air-cleaning technologies and people boasting about the effectiveness. I wouldn't want to single out any one technology here and say this one doesn't work, but I think what we can say is there are certain technologies that have been established over a very long time—things like air filtration, things like UV—that we can sort of say they work and we're confident that they're not going to produce any effects on the indoor environment that are going to be bad for occupants. I'm happy to point you to some literature on that as well.

The Hon. SUSAN CARTER: Thanks, that would be good.

MARK VENDER: The ASHRAE 241 standard that we spoke about, they've certainly grappled with this, I think, and looked at what sorts of technologies could be used to improve indoor air quality at those times.

The Hon. SUSAN CARTER: In terms of Australian building standards, are you aware if there is any work or it's on an agenda anywhere to develop building standards with respect, for example, to humidity—or is that just not currently on anybody's work program?

MARK VENDER: I'm not aware of any work going on at the moment around that. We've just been at a conference today, actually, where we've heard from the Australian Building Codes Board. That wasn't mentioned as one of the projects that they're working on at the moment.

The Hon. SUSAN CARTER: Are you aware of any work or anybody who would have a view—I'm conscious there's many good things that we want to add into the building code, but I'm also conscious that often that adds to the delivery cost of new housing. I'm just wondering if you have any understanding of what the cost might be if these sorts of standards were built in.

MARK VENDER: I guess what I can say is definitely the environment at the moment is very much about trying to keep the code—especially for residential—without too many changes, and keeping costs down and making housing affordability and speed as high as possible. So, no, I can't really offer much on what sorts of codes could be built in there.

The Hon. SUSAN CARTER: If we change the building codes, what impact does that have on already existing housing stock?

MARK VENDER: There are situations where if remediation work is done, we need to bring it up to the current code, but in general it's going to be treating the new stuff. We do get left with a huge—

The Hon. SUSAN CARTER: So it's like pool fences: If you change something, you have to bring it up to code, but if you change nothing you leave it as it is?

MARK VENDER: I'm not sure about the pool fences bit. It may be a really valid example. Yes, if you do remediation works that affect the building significantly then you do have to look at what is the current code and bringing it up to the code.

The Hon. SUSAN CARTER: I'm conscious that there's been a lot of discussion about this; I'm just trying to get it straight in my head. It's your proposition that in terms of what are the standards we should be looking at in the absence of any uniform standards you believe NABERS rather than WELL or rather than WHO?

MARK VENDER: I think that standards like what we've got in WELL and also in Green Star are really good ways of moving the market, but what we see as the benefit of NABERS is it's a space where it brings together a whole lot of things in an infrastructure that's already in place for a lot of buildings. As I mentioned in the opening address, we've got this CBD program which essentially says if you've got this kind of building and you're leasing or selling, you have to get a NABERS rating. We've already got this built into legislation, and I think it's a great platform where we've got assessors, we've got training certification, all that kind of stuff in place. It seems like a great springboard for doing more. That would be our recommendation. Look there. They're very good at building rating systems as well. They've done it for a lot of different areas. Not just energy, but waste. There is an IEQ rating, as you know, and one for embodied carbon, so they have a lot of experience in doing these things and doing it well. I don't know if you've got anything to add to that, Claire?

CLAIRE BIRD: I'd just like to refer to the Energy Performance of Buildings Directive from the EU, which you may have heard from previous testimony. This was actually a directive that is designed primarily for energy performance when there are modifications to buildings. So if you modify a building, what happens? How does it perform? The whole process is designed around energy efficiency, but as of 2024, the 2024/1275 directive actually now includes a rating tool within that framework. Under I think it's article 1 part 2 (h), it talks about having to do an indoor environment appraisal as part of that energy rating tool.

That is what attracts me to NABERS, is the fact that NABERS is conducting ratings for both energy efficiency and indoor air quality. I think as well there's always got to be a financial argument for doing this: Productivity, savings in energy efficiency and so on. I think to me that's the best place to see that needle move, because they're going to be collecting data on both sets of information and ultimately we can bring them together as they just have in the EU. That directive is due to actually be implemented from 29 May across EU member states.

The Hon. GREG DONNELLY: Thank you for coming along today. If you look at in the Sydney CBD, from time to time buildings go up which I think are the highest rating for a building. I don't know what they call it, five star, you'd have to tell me. These top-line buildings, whenever they appear, and I'm talking about in the last few years but now and looking ahead, are they pretty much as good as you can realistically get in terms of inside those buildings the quality of the air, such that they are—this is not an area of my expertise and knowledge—but sort of smart technology which in effect has the whole building capable of measuring itself and assessing itself in terms of how to make adjustments, checking air quality, to the extent adjustments are necessary for filtration et cetera? Obviously those expensive buildings can be built to make that as an attraction, and premiums are paid for the rent and all of that, but are buildings getting towards this sort of standard where they actually are alive, flexible entities and structures that can make all these adjustments and assessments, and basically any time of the day, any day of the week and week of the year, you'll get the very best available?

CLAIRE BIRD: It's an exciting future, isn't it?

The Hon. GREG DONNELLY: I suppose that's why I was speculating—because looking ahead at the issue of guidelines, there's always the thinking being done and the investments being made for what's coming next. Trying to sync up, as far as one can, guidelines and regulations, which are always going to be behind the best of technology, is always a challenge. We can't stop you trying to improve, but where is this all going, particularly in terms of big buildings?

CLAIRE BIRD: It is going to those almost self-managing buildings. That is where we really do have to look to these fantastic tools like WELL, which is there for that very purpose, for creating those safe spaces. People spend many hours in their offices. Not everybody is still working from home. Protecting those environments is a critical part of public health and workplace health and safety as well.

MARK VENDER: There is a benefit to having these buildings with amazing air quality, absolutely, and technology comes into play there for sure. I guess we talk about the top end of town and getting these amazing spaces, and the systems that we have that are for building owners and developers who aspire. They're great frameworks and they work pretty well. Where we need action is in the building types where that model isn't going to be so effective.

The Hon. GREG DONNELLY: No, I do appreciate that.

MARK VENDER: That's why we talk about spaces like schools as being a real focus and, where that market-driven model is not so strong, what can we do to make a difference.

The Hon. SUSAN CARTER: I'm aware that SafeWork has safe levels for particular types of workplaces—for example, tunnelling operations. Are you aware if SafeWork has any standards, guidelines or any sort of thresholds which would trigger an investigation for what we might call a white-collar workplace or a health workplace or an education workplace?

CLAIRE BIRD: I'm not aware of any, no.

MARK VENDER: I do understand there's work going on at the moment on some of the work health and safety standards.

CLAIRE BIRD: WHS, yes.

MARK VENDER: That's right, and the biological hazards one that came out last year.

CLAIRE BIRD: There is work going on, but not for specific settings, is there?

MARK VENDER: Just workplaces.

CLAIRE BIRD: Yes, generally workplaces.

The Hon. GREG DONNELLY: Is that Safe Work Australia or SafeWork NSW, or you're not sure? You can take it on notice.

MARK VENDER: Yes, for sure. Better than us saying yes or no right now. Better to check.

The Hon. GREG DONNELLY: That'd be great.

The CHAIR: We're nearly out of time. Were there any particular points that you wanted the opportunity to raise that we haven't asked you about?

The Hon. GREG DONNELLY: Do you like the air in this room?

MARK VENDER: You've got monitors, I understand, right? How are they—

The CHAIR: We've gone up to 790.

CLAIRE BIRD: Thank you very much for letting us offer our ideas—

The Hon. GREG DONNELLY: No, that's been very helpful.

CLAIRE BIRD: —and for organising this. It's so good to see you all take a lead in this.

The CHAIR: Thank you so much again for your time and sharing your expertise with us. There were a number of things taken on notice, so the secretariat will be in touch with you about those and any supplementary questions the Committee might have as well. That brings us to the end of today's proceedings. For those watching online, the Committee may or may not have future hearings. It's to be determined at this stage.

(The witnesses withdrew.)

The Committee adjourned at 17:00.