What's the deal with indoor air quality?

A conversation with Georgia Lagoudas
November 19, 2025

David Roberts

Hello everyone. This is Volts for November 19, 2025, "What is the deal with indoor air quality?" I'm your host, David Roberts. The modern environmental movement was practically built around the fight for clean air. However, if you look back over that history, you find that virtually all of these past battles and these subsequent laws and regulations were about outdoor air. Indoor air quality — the health effects of the air inside our buildings — has received only a tiny fraction of that attention from advocates and state officials.

But indoor air quality is only going to become more important in the coming years. For one thing, climate change will drive more people indoors more often, more people will be seeking respite from wildfire smoke indoors. Climate change will accelerate the emergence of new pathogens and the spread of pandemics. And our experience with COVID suggests that our indoor air quality management falls well short of what is needed on that front.

It all adds up to an urgent need for climate and public health folks to pay much more attention to indoor air quality, which may be the biggest opportunity to improve public health in the 21st century.

It is obviously folly to pretend that I can cover this entire subject in the space of a single podcast, but I am going to try to hit the high points, and I've got the ideal guest. Dr. Georgia Lagoudas has a degree from MIT in Biological Engineering, which I didn't even know was a thing. But

apparently it's useful because she has used it to advise the US Senate, the Department of State, and most recently the Biden White House on biosecurity and biosafety. She spearheaded a number of Biden initiatives, most notably, for our purposes, a White House initiative to improve indoor air quality.

She is now a Senior Fellow at the Pandemic Center at Brown University's School of Public Health, where she is running the center's Clean Indoor Air Initiative and recently spearheaded a Global Pledge for Healthy Indoor Air.

I'm excited to talk with her about the current state of indoor air quality, the basic technologies that can improve it, and the kinds of policies we need in support. And yes, I will ask her about your box fans.

With no further ado — Dr. Georgia Lagoudas, welcome to Volts. Thank you so much for coming.

Georgia Lagoudas

Great to see you, David. Thanks for having me.

David Roberts

There's so much to talk about. You've spent your entire career studying this, and we're about to cram it into an hour, there's so much to do. Before we really jump in, tell us a little bit about this global pledge for healthy indoor air. What is that exactly? And how did that come about?

Georgia Lagoudas

You've talked about a lot of different topics on the podcast, focused on so many aspects of clean energy, and I'm delighted to see indoor air quality as a topic you're adding in. I came at this topic just a few years ago and I thought, "How are people not talking about indoor air quality?" I was a climate nerd previous to this. I used some of my bioengineering to work on biotech for improving impact on the world and sustainability, but found myself here and I'm excited to talk about it today.

The Global Pledge — we launched a global pledge on healthy indoor air at the United Nations in September, just a few weeks ago. This was during the UN General Assembly. I know you and others were in New York City during Climate Week, running around the city. I was doing the same.

David Roberts

We were all sharing the same traffic.

Georgia Lagoudas

I think I also went to a wrong building as you did once and had to jump on a bike. This pledge is the first time to declare clean indoor air a fundamental human right at the highest levels. From the United Nations, from governments — France and Montenegro are two countries that signed the pledge and launched it — and from a global public health community, we had about 165 organizations sign the pledge. This has been done at a micro level and in communities to say, "Indoor air quality matters." But this is the first time we've said something at the United Nations.

We had the Under Secretary of the UN, Inger Anderson, who leads the UN Environment Program, there. She spoke about this. She talked about the intersection of indoor and outdoor air. We can't ignore indoor air. The purpose of this pledge is to lay out the priorities for indoor air quality, why

it matters to us as humans, why it matters from pandemic preparedness and climate resilience and human rights, accessibility for all, workplace safety. And then, bring together a global community and a movement. Building from this, we plan to have a multi-year effort to expand the pledge and bring this to the agenda of other international gatherings across the world.

David Roberts

Preaching to the choir here, but it's a little crazy when you look into this, how little there's been — of all these international declarations on anything you could imagine, it's a little wild that this has not come up before. I guess it's one of those ideas whose time has come. Looking into it now, I'm thinking, "Of course, that's the air you spend most of your time in." I want to start with what I think is a very basic question in all the senses of basic. I'm familiar — I've been at this for a while but studied outdoor air pollution a long time.

I know who the top offenders are in outdoor air quality. I know particulates are the heavy hitters, there's NOx, etc. When I'm talking about indoor air pollution, is there a bounded set of pollutants that I'm talking about? When I measure indoor air pollution, what exactly am I measuring for? Who's on our most wanted poster here?

Georgia Lagoudas

It's quite similar to outdoor air except for, importantly, one addition that we do measure outdoors, but we don't often think about it in the context of air quality and what we're breathing. The two primary — if I start at the top of the pyramid and expand down — the two primary are particulate matter, importantly PM2.5. We care about that outdoors. That's what comes out of wildfire smoke and car emissions, combustion sources, industrial emissions.

David Roberts

We've covered the science of that on a previous pod, so we don't have to go over it again. To summarize the science on particulates for the past several decades — all point the same direction. It's worse than we thought. There is no safe dose. Everything we find out about it is worse than what we thought.

Georgia Lagoudas

Yes, there is no safe dose. Recently the EPA lowered the standards for particulate matter and the WHO has also lowered the standards for particulate matter. Now we're close to — I think the WHO is 5 micrograms per cubic meter of PM2.5, which is quite low. We're realizing that even going from 5 to 0 is strongly beneficial to your health, from going from 30 to 20 or some high levels. So particulate matter is bad. The science angle of that is, those tiny particles enter your bloodstream and that's where it gets scary.

They cannot just impact your lung, but they go to your brain, they go to your other organs. The second one we importantly care about is carbon dioxide. This is for two reasons. One is that it affects your brain, it makes us function less well, it makes us dumber when CO2 is high.

In a very literal way — there are CEOs that say, "I won't make decisions when the carbon dioxide is above 800 parts per million because I am dumber. I do not think as well. My critical thinking skills are diminished." I have a CO2 monitor that sits on my desk and I carry this around with me and I share this to turn this invisible metric into something visible. We talk about measuring CO2 outside as we think about global warming as a metric, but we care about CO2 for two reasons. One is our brain health, and the second is that it's a proxy for rebreathed air or other air that you share with people.

If I'm in a room with other people, CO2 will rise, and that means I'm being exposed to potentially pathogens that they have — someone sick with COVID or sick with influenza. This is a metric to say, "I should probably be filtering the air and getting some outdoor fresh air in here."

David Roberts

I see. It's a proxy for how much we're sharing?

Georgia Lagoudas

Yeah. I brought this monitor with me when I testified at Rhode Island. We were supporting a bill on indoor air quality in schools. I put it on my desk when I sat up there in front of the House Representatives. I watched as CO2 ticked up as people filled this old, classic style building in Providence, Rhode Island. When I was speaking, when I was testifying, it had gone up to 2000 parts per million. Not great ventilation, that building. I told the representatives,

David Roberts

We're all dumber.

Georgia Lagoudas

We're all dumber. Also, 2000 parts per million means that for every breath you take, 4% of it is someone else's breath.

David Roberts

Wild.

Georgia Lagoudas

You are breathing in — we're sharing this air. All of them looked at me with raised eyebrows and were suddenly scared.

David Roberts

What a disturbing research project it would be to go to House legislatures across the country and measure the CO2. It might explain a lot. I think it's rare outside for CO2 to reach concentrations where they have this sort of direct health effect. Obviously, it's climate we're worried about when it's outside. Why does CO2 gather, concentrate inside? Is it just poor ventilation and rebreathing? Is that the whole story?

Georgia Lagoudas

There's some similarities with particulate matter, but slightly different ways that you can reduce the pollutant. CO2 — the problem is that we can't capture it through filters. Particulate matter, we can filter the air. There are three main ways of cleaning the air. You filter it, you run it through tiny pore sizes. Number two, you ventilate, which means you bring outdoor air in and exchange air. Three is you can disinfect the air. This is through some technologies called UV where you shine light and you zap it. This is common practice for decades in hospital settings.

In some hospitals you'll have upper room UV, shines a light, zaps the pathogens, kills them. Less common in public non-healthcare settings. Those are the three tools we have. Filters are by far the easiest and cheapest because you don't have to worry about heating and cooling the air or addressing humidity and so forth.

David Roberts

Just so we're clear, we're worried about particulates, we're worried about CO2. Those are the two big ones. There's also a couple of strays, aren't there? There's a couple of others.

Georgia Lagoudas

Yeah, there's a few others. Then we descend. I mentioned those as the two easiest in that we have low-cost accurate monitors we can use to measure them. They give us a really good proxy for most changes we want to make in a building for ventilation or filtration. Then we go to a second tier of additional ones that are good and important to measure. There we have a category of compounds called volatile organic compounds. These are things like benzene and formaldehyde and scary sounding names. A lot of this comes from paints and carpets and furniture.

David Roberts

Cooking. Am I making that up?

Georgia Lagoudas

Some cooking — combustion sources of cooking. If you have a gas stove, you can have benzene there. You also add nitrogen dioxide and some additional compounds that come off that. Nitrogen dioxide is an important one. We also have carbon monoxide. Many of the buildings we live in already have monitors because carbon monoxide is so dangerous to health. Those are a category of compounds you can measure. Volatile organic compounds and other gases in the air. We talked about particulate matter. There's other forms of particulate matter — particulate matter 10, larger particle sizes.

Then you also go to a category of biological compounds. I'll call them biological pollutants. These are things like allergens or mold or bacteria or viruses. Those are harder to measure in the air. This is a newer area of research — how do we actually have sensors that can detect those in real time.

David Roberts

Interesting. Okay, so those are our enemies indoors. Let's talk briefly — technology. I take technology from two sides. One, the latter is probably more important, but the first is exciting to me as a geek, which is if I were building a new building, say, a 10-story apartment building, what does state-of-the-art, cutting edge, in terms of indoor air quality look like? What am I doing to a brand new building? If money's no object, what is the best out there?

Georgia Lagoudas

If money is no object and you want the best building, number one, you want high levels of ventilation. You're going to pick the highest standards that exist around the amount of fresh air per person or "equivalent clean air" is a term used in the field, which is how much for people that are in the building and making sure that each of them gets this amount of fresh air. We also have demand control ventilation. We don't ventilate the building when it's midnight and no one's in the building, but we're doing it efficiently so that when people are there.

With demand control ventilation, you have sensors in a building. You have sensors that measure CO2 and measure particulate matter. Importantly, if they measure CO2, they know when you have a lot of people in the building. The highest end buildings will adjust to keep CO2 below a certain threshold.

David Roberts

I see. Variable ventilation that will sense how much is needed at the moment.

Georgia Lagoudas

You're ventilating at a high standard at a baseline. Number two, you're adjusting based on people and the conditions. Whether it's wildfire smoke outside or people inside, you're maintaining something. You have some opportunity for further adjustments to say, "It's flu season and we want to crank up the ventilation," or "We want to focus it in on this auditorium where lots of people are coming." You have some ability to adjust in the building and all of this in an energy efficient way, which means you're using things like energy recovery ventilators and heat pumps to make sure you're doing it at the lowest possible cost for energy and efficiency.

David Roberts

The heat exchanger — you just pull the heat out of the air before you vent it back outside, so you don't lose heat?

Georgia Lagoudas

Exactly.

David Roberts

One of my big questions here is — just ventilation, the best you're going to get there is equalizing indoor and outdoor air quality. There's got to be some filtering. There's got to be some cleaning of the air. If there's fire smoke outside and you want your air cleaner than outside, you need more than just ventilation. What is the filtering stage?

Georgia Lagoudas

You need both — ventilation and filtration. If we have people inside and we want to keep things like CO2 at a lower level, you also need to be able to ventilate and filtrate. If I'm living in a polluted city and I open my window, I'm going to get whatever the particulate matter is out there inside my building. You need to bring in air, run it through a filter, do that in an energy efficient way, and then recirculate it back outside. You're doing essentially both at the same time.

David Roberts

Your ventilator intake has a filter in it?

Georgia Lagoudas

Yes. This is what heat recovery ventilators or energy recovery ventilators have, which is the unique and special thing about something that's different from a heat pump, which can provide heat, or sometimes people will have mini splits or AC units that are sitting up and they're circulating the air in the room and they're heating or cooling it, but they're not exchanging air from the outside. The really unique and efficient thing that energy recovery ventilators do is they bring in outdoor air. They do this heat transfer, so you're really efficiently heating or cooling the air, you're filtering it, bringing it inside, and then you put it back outside and you create this loop that does both ventilate and filtrate.

David Roberts

So your ventilation and your filtration and your heating — really some of your heating — are all kind of in one big step. Is there anything to say about filters? Is the technology of filters particularly interesting or has it advanced much in recent years? Or do we more or less know what we need to know about how to filter air?

Georgia Lagoudas

We've known this for almost a century — basically World War II technology. As we figured out how to make filters, they're mesh fibers. You can add an electrostatic charge to capture particles more efficiently. We've known how it works, we just haven't fully implemented. The story I'll give is that there's different ratings for filters. We often hear HEPA, which is a form of really high capture efficiency of particles. There's also a different rating that's lower than HEPA, which is a MERV rating of capturing different particle sizes. Buildings commonly use MERV 8, which is one category of filters recommended by the CDC. And other standard bodies are closer to MERV 13.

The difference is that MERV 13 captures 77% of virus particles. MERV 8 captures little to none, around 10%, depending exactly on the —

David Roberts

So there's a threshold, a distinct threshold there.

Georgia Lagoudas

We've often thought about filters — this came to light entering the COVID pandemic. We often thought of filters as, "Okay, capture the big chunks and that sounds good." But we hadn't thought about health-based air standards, that air should be healthy not just from particulate matter, but from disease. We shouldn't get sick from the air. This was a new paradigm. During COVID, we were like, "How do we make the indoors more like the outdoors?"

David Roberts

And that's just a tighter version of the same filter. It's just a tighter, better version of the same. And mesh doesn't sound particularly expensive to me. It doesn't sound like this is a particular cost center. You can get good filters.

Georgia Lagoudas

You can even build your own air purifier.

David Roberts

Yes, we've got a lot of questions about that, believe me. I threw this out on Bluesky and turns out there's a whole robust community of people obsessed with building their own air filters. That's a state-of-the-art big building. If I'm just building a residential home, is it the same thing? Air intake and ventilation, filtration, heat exchange, same basic thing?

Georgia Lagoudas

You have all the same basics. You want to ventilate and do filtration. Ideally you do that with something like an energy recovery ventilator so that you can be doing both at once.

David Roberts

That's pretty expensive though, at the residential level, isn't it?

Georgia Lagoudas

There's an upfront higher cost. You might say, "I just want a heating source." You can do what I'm doing in my apartment, which is I crack the window and I run air purifiers to enhance bringing in some outdoor fresh air. The problem is if you seal up your home and you're not having a way to bring some outdoor air in, you're just accumulating all of those indoor pollutants and CO2 and all the people you have over from your dinner party. Different options for folks at home.

Having a well-functioning HVAC system is really important because it basically allows you to set and forget. You replace your filters and you run it and you have a technician check it once a year, have those high quality filters and then ideally, if you have the means, have something like an energy recovery ventilator to allow you to efficiently heat and cool air, but also filter it.

David Roberts

Got it. The problem is most people out there are in buildings that are already built and we would like to make those safer. Is that a substantially different undertaking than building a new system? What do you do with, say, a 10-story apartment building that's got whatever was off the shelf in the 1990s? How difficult is retrofitting this stuff to bring it up to decent standard?

Georgia Lagoudas

You said a key word there, which is retrofitting. There's a few things you can do in existing buildings. It's a really important question because the majority of the building stock is existing buildings. We have challenges like close to 50% or so of schools may not be mechanically ventilated. A lot of schools don't have HVAC systems that are centrally controlled mechanical ventilation systems. That just adds another layer of saying these are really important places where kids learn and work for eight hours a day. We're dealing with many buildings that don't have mechanical ventilation.

The first and most important thing to do is a commissioning of the building system if it has mechanical ventilation — get an engineer to come and check your system. I've heard way too many stories of no one having looked under the hood of the ventilation system of a building and finding, number one, terrible things in there, like old animals' nests or mold or other bad stories. Number two, just like you tune up your car, you need to do some adjustments and maintenance of this equipment, which is your mechanical installation. Commission your building is a recommendation that I give and many others in this field.

Often by doing this — it's like a tune up. By doing a tune up of your building, you can save energy costs too, because you're fixing some issues that arise. Number two is assess where you have poor ventilation or filtration or where you need to make changes and do the best that you can with either resources or equipment. We've engaged with the Boston Public School District. I think it's 70% of the buildings are not mechanically ventilated. They deployed indoor air quality monitors in every classroom across the school district. This is the oldest school district in the United States.

They just put monitors in to measure what's there. They're measuring CO2, particulate matter.

David Roberts

And that's cheap too, right? These monitors, these are cheap devices.

Georgia Lagoudas

This is order — you can buy monitors, order of $100, $200. You can go up for a little bit more fancy components, but you can buy them at a pretty reasonable price now. They deployed those in all the classrooms to see what's going on. Then they made adjustments that could include a number of things. One was they made sure windows are working. They updated windows. Make sure in your home if you have functioning windows. Number two, they put in air purifiers in a large fraction of classrooms.

They didn't have this mechanical system to run it through the HVAC system. They put in these local air purifiers. They bought it to the size of the room so you can do the same thing in your home, in your bedroom, in your kitchen. Number three, they made other adjustments where appropriate. Maybe they bought updated window units that might have filters as well or what kind of heating they have to make sure that that's appropriate for the room. I'll give you a very example — I'm currently working with the country of Montenegro on how they can advance indoor air quality and bring healthy air to all of their schools in the country.

Montenegro was one of the countries that was at the United Nations event and they have a really different problem because a large portion of their rural schools have wood burning stoves.

David Roberts

That is, we should just say, in terms of indoor air quality outside of the developed countries, that is the big thing.

Georgia Lagoudas

There you need to replace, you need to upgrade that wood burning stove to some clean form of heating source for those kids and do so in a way that you're also making sure the air is clean and safe. We're working on a very different set of recommendations for those entities from the classic home in the United States.

David Roberts

I mostly want to keep this constructive and forward looking, but you've touched on something that has always bugged me. I'm going to ask you about it because you seem really well placed to have some insights on this. I thought that COVID made several lessons very obvious and that we would all learn them. I turned out to be very wrong about that. A lot of people did not find those lessons obvious and we did not learn them. I thought, if nothing else, surely we've learned that it's not good that a bunch of kids are in schools that are actively making them sicker.

Surely if nothing else comes out of COVID we will come out of this with a commitment to indoor air quality in our schools. Surely that can't be partisan. That can't be controversial. My sense is, it did not galvanize anything. There was no big burst of action. We're not much better off now than we were then. If nothing else, why didn't we come out of COVID at least committed to better air quality in schools? They learn better. Their brains are literally forming. Their personalities are literally forming. These are lifelong effects with tiny, cheap interventions. You can't find a public policy intervention where you get more bang for your buck than not poisoning children's brains. Why did we come out of that whole experience with no tailwinds at all? What happened?

Georgia Lagoudas

Great question. I will take a sigh with you, David, because I feel the same amount of exasperation. That is why I am working on this topic now. In some ways, when I was at the White House and thought about this, I thought, surely there's an organization, there's a group — they're working on this, they're figuring it out. How do I call them and support them and say, "Great, keep going, guys!" There wasn't. The number one issue is that indoor air quality falls between the cracks of many disciplines and many decision makers.

One example is I went around the federal government. I was serving as a senior advisor in the White House during the Biden administration and during the COVID pandemic. I said, "Let's see, who's in charge in the federal government? Who should I call and say, 'Hey, air quality is important. How do we help you talk more about it?'" I called the CDC, and the CDC said, "We do public health, but this is more of an environmental topic. Talk to the EPA."

EPA is like, "Not quite us." The National Institutes of Health. Call NIH and, "Oh, this is more applied, not basic research. Call someone else." There was a pass the buck because it falls peripherally in many people's mission and purview, but it is not central to one. Is it a public health issue? Is it an environmental issue? Is it a workplace safety issue? Is it a biosecurity issue? Is it a defense issue? All of these components.

David Roberts

It is all of those.

Georgia Lagoudas

There wasn't someone in charge, David. That was the most frustrating. I think that is one component. The second is that we didn't have clear playbooks or targets of what exactly to do. We quickly threw a band-aid on the problem, bought a lot of air purifiers. The market was flooded with a lot of companies, some good, some less good, selling all sorts of things. Then you asked a teacher to plug in the air purifier in the corner and remember to turn it on or off every day. If the janitor unplugs it, to remember to plug it back in. That doesn't work. That's not system-level durable change. We didn't have that in place. The third thing is that we weren't aligned around what metrics to ask for and to demand. I carry around the CO2 monitor because it allows me to turn this invisible thing into a visible thing so I can walk into a public space and say, "The CO2 is above 2000 here. That's unacceptable. That is unsafe. That means there's a lot of shared air. We're not doing enough for our brain and our respiratory disease."

We didn't have this concept of demand. If we did, as the COVID pandemic continued and the politicization, it was then less acceptable to want to ask for this, to demand clean air as a right due to COVID. There's been a lot of shift in the dialogue right now to talk about outdoor smoke and exposure to outdoor smoke. How do we reduce asthma and allergies? That's okay. That's great. There are many benefits. I actually think this aligns really well with the Make America Healthy Again movement.

This is a great opportunity. If there are some champions there that care a lot about clean environment and what their children are exposed to —

David Roberts

They say they do.

Georgia Lagoudas

I think everyone can win. We're still working on how to gain traction so that we can all figure this out together.

David Roberts

As you say, it's very diffuse and just like the administration of schools in the US — local. There's not a lot of central levers you can pull that affect all schools.

Georgia Lagoudas

I went down this rabbit hole — very effective rabbit hole — learning about how is our building air quality maintained. It goes down to this technical and nerdy but really important society ASHRAE: the American Society for Heating, Refrigeration and Air Conditioning Engineers. They're the ones that write building codes that are adopted across the world, not just the United States. The problem is that all of these are adopted at the state and city level.

David Roberts

Let's pivot then to policy. This is a good segue. As you say, there's several problems, a bunch of different solutions, a bunch of different organizations involved, pretty diffuse. If you're advocating for policy at the state level — I am, for the time being, just ignoring the federal government — if you're looking at state level, if I'm a state lawmaker, I listen to this pod, I'm thinking, "This is important. Nobody's paying attention to this. I should do something." What is it I'm doing? If I have a top three priority list.

I know you recently worked on and got a bill passed in Rhode Island. Use that as an example. What is good state policy here?

Georgia Lagoudas

I advised a bill and we actually didn't fully get it passed. It came out of the Senate, not the House. We're going to work on it for one more legislative cycle. It's hard to get a bill passed in one session, as you probably know. It takes groundwork.

David Roberts

I also wonder, who is the other lobby? Who's fighting this, or who's the enemy of indoor air quality?

Georgia Lagoudas

The only pushback we had was that this costs money and how are we going to pay for it. It's mostly a money concern. What we did in Rhode Island was, number one, the main outline of that bill and my number one recommendation to lawmakers is look at it in your schools and the place where you have your most vulnerable population and make sure the air quality is good. We advised some of the leaders in Rhode Island to come up with a bill for what works for the state of Rhode Island. In this case, it was, number one, put some guidelines out so the Rhode Island Department of Health publishes numbers.

What should we aim for? What is good and bad for indoor air quality? There's different ways to go about that, but basically, CO2, particulate matter. Number two, check the ventilation in your school buildings every so often. In Rhode Island, we said do it as a part of the every five-year school building infrastructure assessment. Every five years is not that frequently, but it is a place to start because many schools, the only time you have to check ventilation of your building is when it's built. That's what the standards are built for — they say "When you build a building, this is what's required to happen."

Most states and cities adopt the building codes and they leave out the operation and maintenance part. There's no requirement years later to check your ventilation. Number two, check the ventilation of your buildings. Number three was upgrade the quality of the filters. Go up to the MERV 13 that captures the biological contaminants, viruses, bacteria in the air. That would be my first top line recommendation to a lawmaker.

David Roberts

I do worry about this just translating into more requirements and obligations on already beleaguered school administrators. You'd also like to give them some help. I don't know what that would look like exactly.

Georgia Lagoudas

Different states have passed funding packages. Connecticut passed some funding to support — a part of it was a really cool component which was in partnership with the University of Connecticut, do a statewide school education and air purifier building campaign. Teach students how to measure air quality, how to take action on their own hands, but also fund schools to be able to do upgrades.

David Roberts

This does seem like something that kids could do. Measuring CO2 in a room is pretty straightforward. If you can get them excited about it, it seems like you could distribute a lot of this.

Georgia Lagoudas

One of my colleagues has actually made a little Game Boy air quality monitor. It's like a Tamagotchi for air quality. You need to keep your pet happy and healthy, and you do that with air quality. It's been cool to see it distributed and people get excited to say, "Now this is a thing I can interact with and understand."

I think there's opportunity to get kids involved. The thing I'll say, David, you're thinking, "This is hard and it costs money and it's going to have more requirements for teachers or school leaders," and it is unacceptable to have poor indoor air quality.

It is unacceptable that we're exposing children to potential long-term health effects. We haven't as a society arrived there. That is my hope and goal of how this work can move forward — that we should say "It can cost money, but we're going to decide that the health benefits outweigh the costs."

David Roberts

That's what we did with outdoor air very explicitly in the 70s. The Clean Air Act basically says make the air clean. It doesn't say anything about how much it costs. It just says, "Here are the standards, meet them." We just never did that with indoor air.

Georgia Lagoudas

We haven't arrived at it to say "It is something I deserve. I should have indoor air quality. It's unfair if I don't have indoor air quality." I think we are still in this education component that we need to recognize what to ask for and what is good or bad. Just like you said, it was a no brainer that we arrived at this for outdoor air. I see the smog over LA. That looks gross. I don't want to breathe that. Or I smell the fumes from this car.

Indoor air pollution is a little trickier because we don't have plumes of smoke, usually indoors, and the compounds are less smelly. We don't have as much of these visible, tangible aspects to trigger us to say, "This is unfair that I'm being exposed to this."

David Roberts

Again, preaching to the choir. I don't know how much time you've spent digging into education policy, but it is a vortex of madness. Nothing works. No one knows anything. Everyone hates everybody else. No one can figure out a truly efficacious educational intervention. They all fall apart at scale. This is the thing about education — nobody really knows what to do. Here is measurable, testable, absolutely predictable improvements in student performance. If you want improvements in student performance, it's very difficult to figure out how to get them.

But here's one thing that absolutely works. Literally, don't poison them.

Georgia Lagoudas

We don't have the leaders championing this and people holding the microphone and bringing this to student leaders. There are not a set of organizations dedicated to this for whatever reason. Public health campaigns have been triggered by something. Ideally, in some ways, COVID could have triggered that for indoor air quality. We don't have someone selling the principal to say, "Students will have a 13% reduction in absenteeism. They're going to show up more. Your school's actually going to get more dollars from the federal government in some cases because the students are showing up."

It's actually payback. Number two, student test scores will increase 10%. All these things — we haven't created both the educational pitch and the economic pitch to education leaders. The hard part is you have to do that to everyone. There's not this centralized rule.

David Roberts

It's something I've learned over and over again over the past several decades — it doesn't matter how obvious something is, if it's just sitting there being obvious, somebody's got to go yell the obvious thing. Somebody's got to go say the obvious thing loudly and repeatedly, even if it is obvious.

What about at the city level? I think the state is the best ideal locus here for policy. Are there things cities specifically could do? You mentioned Boston. Any city could pass out sensors. Are there particular other things cities can do?

Georgia Lagoudas

Cities could have sensor deployment, monitoring programs. Whether you rent them or give them out to households or schools.

David Roberts

Don't you have to have a carbon monoxide sensor by law in buildings? Couldn't we just add CO2 to that? I don't know what a carbon monoxide sensor really is, but how hard would it be to also require CO2 sensors in addition?

Georgia Lagoudas

Absolutely, we could do it. You can write it into law and make it exist, David, it can happen. The question is what you do with that. Why should we pay for it? If you have a CO2 monitor — many newer buildings have this, many rooms now have CO2 monitors in the ducts and in the little temperature monitoring device buildings. It's not uncommon for many buildings to already have CO2 baked in, but we don't have requirements for it. Yes, there could be requirements just to measure. Belgium in 2022 passed a law that said all public spaces of the country must have a CO2 monitor and visibly present this to people coming in and they're going to phase this in.

David Roberts

If you want to induce building owners to make these investments, that's one way — if everyone who walks in can see exactly what your indoor air quality is.

Georgia Lagoudas

In some ways you can say — Belgium right now is not having mandatory requirements. It's just saying "Make it visible."

Suddenly, if you can put on the wall these numbers just like restaurant food safety grading — you get an A or a B minus. You're thinking, "I'm not sure about that C food safety rating if I want to eat there."

David Roberts

Or if you're choosing a school — "This school will make my kid dumber. It says so right there on the wall."

Georgia Lagoudas

This goes back to this earlier point — you can be empowered and you can empower those around you with air quality monitors, these low-cost, decently accurate ones, just measuring your spaces. To answer your question, David, about what policies — I want to put a few on the table for city lawmakers and state lawmakers to think about. One is about schools, whether it's supporting school ventilation assessments or building commissioning or programs where you deploy monitors, deploy air purifiers. A second, especially at the city level, is building code council.

David Roberts

My third question about policy was about codes. It's unclear to me exactly who's in charge of those. If you wanted to intervene in that process, what do you do? How do we start changing these codes?

Georgia Lagoudas

It is a harder to crack box, that becomes technical and a little more siloed. At the city or state level, you can require certain building codes. Many states will require that in law. California has certain state building codes. There's a commonly used building code that is common for many school districts across the nation.

David Roberts

Am I right in saying — and maybe I learned this from you and I'm just preaching back to you — but current building standards typically have requirements about the temperature and comfort of indoor air, but they just don't have anything about the health.

Georgia Lagoudas

Right.

David Roberts

Is that a fair generalization?

Georgia Lagoudas

Maybe just to close out policy actions and then let's dive into building codes because there's a lot to unpack. Adjust the building codes to the latest and do a full adoption of them. Adopt all of it, not just those first building requirements. A third really important thing is this thing we said at the beginning of why was this a missed opportunity during COVID. My first answer to you was there was no one in charge. It falls between the cracks at the state and city level. Absolutely. Pick someone, just pick someone, make them in charge and make them run an interagency task force, whatever that is.

You can have all the people at the table, but have someone have the decision making power. Those are a few recommendations. We published a state guide for indoor air quality with two dozen organizations two months ago from Brown University and tried to outline actions for state governors as well as school leaders and other settings.

David Roberts

There's a template now if you're a state or city leader, you can go consult this.

Georgia Lagoudas

Yes. There's a whole team of organizations standing at the ready to help you. If you at the city or state level want to take action, we can help you find people, technical experts that will help you actually do that implementation or guide the steps. Now maybe diving into building codes, because that is its whole other section. You called out importantly that the way we typically use building codes in the United States is that they're about when a building is first built. ASHRAE, this association I mentioned that writes building ventilation codes — if you go look at the building code, 62.1 is for most commercial buildings for ventilation standards.

That code has operation and maintenance in it. It says every month, every year you need to do these things. Most cities and states just adopt a portion of that building code. One thing policymakers could do is say "We should adopt all of it" — recognizing that there may be pushback because then suddenly building owners have to pay for annual maintenance of the air quality in their buildings.

David Roberts

Then you'll get a counter lobby once you start making people do things.

Georgia Lagoudas

The other piece, David, with these building codes, is that at a first pass, great, let's adopt the existing building codes we have. Let's set a minimum floor. The problem — there's a major problem and we're not going to fix this all at once. We need a multi-year approach. The problem with this building code, the commonly used building code, is that it is not health-based. We do not have a health-based indoor air quality standard in the United States. The way that our building code for ventilation is written right now is it is set at a level of ventilation, whereupon 80% of building occupants do not complain about odor.

It is an odor-based...

David Roberts

That's the literal metric.

Georgia Lagoudas

Yes.

David Roberts

You take a survey. Does anything stink?

Georgia Lagoudas

Exactly. They took a survey of building occupants and they said 80% didn't complain about the smell. We're going to set this level of liters per second per person of clean air. The level that they put it at has changed over time. It actually used to be double. Pre-1970s, we had about 30 cubic feet per minute per person that would come in for clean air. In the 1970s we had the energy crisis and there was an update to say, "How do we make buildings more efficient? Do we really need this level of ventilation? Is that important?" They cut it by half. They cut the ventilation by half, hitting this metric of 80% don't find it smelly. We just lost this concept of health-based standard. That led us to the decade of the 80s, which is when we had this proliferation of sick building syndrome, when you had all these perfectly sealed office buildings with low ventilation and everyone was getting headaches and feeling dizzy and having a cough. We realized the buildings were making people sick because they were so sealed.

David Roberts

This was always a lingering worry out on the edges — what if you do too much? That's not anybody's fault really. It's just that we did not integrate health into the standards that these people were following.

Georgia Lagoudas

We had more of a consensus earlier on, a century ago, around the importance of health in our indoor environment. We lost that because of a prioritization of energy efficiency. What we've done is we've played this dangerous game of improving energy efficiency at the cost of human health. We haven't figured out how to balance both.

David Roberts

Are they always at odds? It is a real trade off. If you are circulating more air, you are using more energy. The trade off itself is not an illusion.

Georgia Lagoudas

It's not an illusion. You can absolutely do both. You can absolutely have an energy efficient building and a healthy building. The amount of cost of energy is pennies, just incremental on the total energy cost. Joe Allen is a professor from Harvard that I've collaborated with. He works in the space. He's done some analyses of these types and found that you can spend about $40 per employee per year of increased ventilation costs and that will give you $7,000 of gained employee productivity per person, almost a 200 to 1 gain. This is because you're spending so much more on your individual employee in terms of dollars than you are on your energy cost of your building.

It's an economic no brainer for businesses and we have to be okay with a little bit increased energy if that's for wanting to crank up ventilation a little bit.

David Roberts

Especially if the whole business class has decided that their employees need to come back to work, maybe they could do their part of the bargain and make the buildings healthy at least.

Georgia Lagoudas

We haven't recognized how much of an impact the air quality has on our health. One of the first examples I'm seeing now of entities and policy bodies recognizing that we have to do both is actually in the European Union. The EU has the Energy Performance of Buildings Directive that has existed for many years that says something about, "Here's a directive to all member states around what energy metrics you have to meet and how you do transparency." Late last year they had a recast or update to it.

For the first time ever they included indoor air quality. They said "You must have a minimum bar of indoor air quality, you must set some minimum standards." It's the first time I'm seeing really at large scale that we have to address energy efficiency, but it can't be at the cost of human health.

David Roberts

Cities can just adopt the whole energy code rather than the first half, that's one thing. But do the building codes themselves need rewriting? What does that look like? Does ASHRAE meet in an isolated building somewhere and release white smoke when the new codes are ready? How does all that work?

Georgia Lagoudas

We can use the existing standards we have and more fully adopt them. We also have newer standards that we could adopt. One that was recently developed two years ago — this was a result of my White House work — was ASHRAE 241, the standard for infectious disease control. It's basically the first of its kind that is a health-based ventilation standard. Cities and states could adopt this newer standard. It raises the floor to say, "We're not just setting this based off of odor, we're setting on making sure people don't get sick." How do we maximize it?

Typically ASHRAE takes about five years to develop a new standard. It's a slow moving body, it's made of volunteers, it's a consensus-based process. When I was at the White House, I was working with Dr. Ashish Jha who was the COVID response coordinator at the time for President Biden. Ashish and I were on the same page that indoor air quality is a no brainer. How do we move the needle on this? We both talked about this and found that ASHRAE developing a new standard could change the field of having some new health-based standard to aim for.

We had a call with them and they developed a new standard in six months. During the pandemic they could do it. They can do it. They brought together not only ventilation engineers, but public health experts. That's not a usual part of their process.

David Roberts

That's really cool. That seems like progress. I have mostly focused on the US here, but I'm curious. Is this general state of things — where this has kind of fallen through the cracks, not getting as much attention as outdoor air, not getting as much attention as other climate stuff, sort of nobody's in charge — is that replicated in other countries? Is that the typical state of affairs or are other countries doing it better? Particularly I'm wondering in the emerging economies because there's a lot of talk about leapfrogging.

You've heard all the talk about leapfrogging. They leapfrogged landlines to cell phones. In energy we're all hoping they leapfrog over fossil fuels to clean energy. Could they leapfrog to clean buildings? Is this taking off internationally? Can you generalize about the state of play internationally?

Georgia Lagoudas

The state of play is slowly moving. I think we are at a tipping point where we are trying to hit some exponential growth. That was what happened at the United Nations. We had 350 people show up from around the world for this event and we had 165 organizations sign this pledge and two countries. We brought together in some ways for the first time — I haven't seen everyone sit around the table that's from the climate sector plus the biosecurity sector plus the public health sector. By doing that, David, we're trying to create this, in some ways, fear of missing out — how can you make change, have others see it and then catalyze action.

France and Montenegro trumpeted what they're doing and kudos to both of them. Montenegro is launching this nationwide effort for clean indoor air in schools. Part of that will be setting standards. I'm helping them develop a policy agenda for how they integrate this in the government. We're facing these similar questions of does the Ministry of Environment or the Ministry of Health or the Ministry of Education hold the deciding power on any of these? That's happening in Montenegro partly because of a wealthy individual, Vitalik Buterin, who has decided this is a really important topic.

Also, like you and I and all the other air club members saying that it's a no brainer, why aren't people taking action? Vitalik is working with the support of the Montenegro government to advance this. Other nations are doing — there's a few cherry picked examples. Belgium, I already mentioned, they're coming at this from workplace safety and individual rights. There's been action from France in advancing schools and nursing homes. There are other entities not in Europe — Singapore and South Korea are two examples. South Korea actually has one of the few Indoor Air Quality Control Acts.

David Roberts

Oh, interesting.

Georgia Lagoudas

It's one of the first to actually talk about indoor air quality specifically. They have transparency requirements about indoor air quality. The United Arab Emirates is another entity that said, "It's really hot outside and it's also polluted outside and it's only going to get worse because of climate change. How do we make sure the space that people inhabit most of the time is clean and safe?" They've required ASHRAE 241, this really high standard for health-based ventilation in all of their buildings in the country. For UAE, it's all government buildings. Dubai has said for all new buildings.

David Roberts

A lot of what's going to be happening in these countries that are getting hotter is just a lot more air conditioning. This is something everybody in energy world is panicked about. We really need to do this well. Are there cheap AC units with filters built in? Can you integrate air quality and air conditioning in a cheap way in the emerging world?

Georgia Lagoudas

I haven't seen much of this and it's wild. There's been a huge effort in India to advance low-cost and efficient air conditioning units.

Most of those do not have filters. Especially in India where there are so many places with so much pollution.

David Roberts

It seems like it would be easy.

Georgia Lagoudas

It seems obvious, David. It seems simple. Remarkably, that is the theme of this conversation — we haven't recognized how much of a no brainer indoor air quality is. It's low cost, the interventions are low cost. It's passive. It just sits in the background and does work for you. The health impacts are so...

David Roberts

And the benefits are compounding. I keep beating this over and over again. You improve a kid's brain, literally his brain — it improves his entire future life. You cannot find public policy interventions that pay back more over extended periods of time.

Georgia Lagoudas

The other thing that I'll say to tie a thread together is we arrived at this for outdoor air. We arrived at this common thread that outdoor air is a human right. The right to a clean environment is a human right. We haven't arrived at this for indoor air quality and we haven't arrived that it is unfair if I'm exposed to it. We spend 90% of our time indoors and often indoors is two to five times more polluted than outdoors.

David Roberts

That's crazy.

Georgia Lagoudas

We haven't been able to get this into the mainstream to understand the impact of air quality.

David Roberts

Final question. It's a two-parter. The average person listening to this pod is an American professional living in their house or apartment. If you were going to advise the average listener, here's a checklist — 1, 2, 3 obvious priorities for your internal air. This gets back to the box fan obsession. Should everybody be building these box fans or is it something else? If I'm prioritizing to maximize my impact, what are the top three things? Second part of the question is similarly for this average listener, if they want to get involved in advocacy in some way for this, who do they advocate to and what do they advocate?

Georgia Lagoudas

Great questions. If you didn't ask me that last one, I would say that's a thing you must do as individuals, think about the advocacy angle. As an individual, number one, buy a low-cost air quality monitor. You can read some reviews online. There's a couple of good technical experts that have given reviews. Buy one.

David Roberts

And it'll be CO2 that's measuring or several things?

Georgia Lagoudas

Usually CO2. I have one that is a CO2 monitor and then I have one that's both CO2 and particulate matter. I would look for one or both of those. CO2 is really powerful because in the United States, where we usually don't have that much pollution outdoors, CO2 is much more visible in terms of indoor contaminants. Number one, buy a monitor and carry it around with you. Test it out in your home. Right now I'm sitting in my office and I've closed all the windows and doors to make sure it's quiet and my CO2 is rising.

It's good to note I'm slightly less smart because of that.

David Roberts

I wasn't going to say anything.

Georgia Lagoudas

Carry it around, not just your home, carry it around, give it to your kids, see what it's like in their school. Take it to your library, take it to your subway. Subways are pretty polluted.

Measure the air quality. Have some awareness to it. You can look at outdoor air quality to learn about how that relates to your sensor. Number two, take interventions in your home to improve the air, which is putting in air purifiers to filter out particles. These are things like what could come from cooking. These are things that could come from hosting a dinner party if someone's sick there, those airborne contaminants. This can also capture allergens. During allergy season, put in an air purifier. I have one in my bedroom and I have one in my common space near my kitchen.

My bedroom — having one where the place that you sleep and you spend maybe eight hours a day is really important. Make those interventions. Number three, think about source control, which is if you have combustion sources in your home, like gas stoves or gas appliances, that combustion — you're burning a fuel and you're emitting all of these chemical compounds that come off of that. We're not just talking about when you fry food and you see all the splatters come out of the potato and the oil frying up, but also just burning that gas continuously sometimes in homes releases these dangerous chemicals that you're often never aware of.

They're ones that we don't capture from these low-cost monitors, but they're there and can have really long-term health effects. If you have the opportunity, make those changes in your home.

David Roberts

Electrify, electrify, electrify.

Georgia Lagoudas

We talked already about energy recovery ventilators as really cool ways to do it efficiently. That's what I'd say for your home and you as an individual. What to do about helping change the world, helping change your environment or your state or your nation or the broader community. How can you get involved and what are ways to be an advocate? Number one, become a champion of indoor air. That means carry on the monitor, be aware. We've just started something that we cheekily call Air Club, which is a global movement for individuals to be a part of and come together, share resources, learn from each other.

Airclub.org is the website that we've created and this was launched during the United Nations event when so many of us together are thinking, "Wait, this is a no brainer, we're all part of this club." If you want to be part of that global community, number two, the Global Pledge for Healthy Indoor Air that we talked about — bring that to your organization, to your school, to your local city. It says many things, but it primarily talks about one important theme, which is clean indoor air is a fundamental human right. We should prioritize this topic.

I also want to recognize Bronwyn King was the co-organizer and co-author of that pledge, a leader in Australia, coming up from workplace safety movements and the public health community. Number three is turn to some organization in your community, whether it's your school district or the leader of the building facilities manager of your office house, or your local politician and ask them about this topic and what they're doing about the quality of the air in that building that matters to you.

David Roberts

In Seattle, we just have been in a long process of updating our comprehensive plan, which is all about zoning and how many floors you can build, all about building stuff. I've been wondering whether anyone in that process is paying attention to indoor air. That would be some good people to bug about it. This has been just perfect, just enormously illuminating. I can't thank you enough. This is super interesting. Such a complement to all the other things we talk about here and such an obvious — as we keep saying back and forth — such an obvious thing to pay attention to. Thank you for coming and walking us through it.

Georgia Lagoudas

Thank you so much for having me, David.

David Roberts

Thank you for listening to Volts. It takes a village to make this podcast work. Shout out, especially, to my super producer, Kyle McDonald, who makes me and my guests sound smart every week. And it is all supported entirely by listeners like you. So, if you value conversations like this, please consider joining our community of paid subscribers at volts.wtf. Or, leaving a nice review, or telling a friend about Volts. Or all three. Thanks so much, and I'll see you next time.