

Strategies for Reducing Air Pollutants from Wood Combustion

Transcript

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Authors: Sebnem Madrali, NRCAN, Canada

Edited by: Hans Hartmann, TFZ, Germany, Morten Tony Hansen, Ea, Denmark

The following text is a transcript of the Expert Roundtable held by IEA Bioenergy Task 32 in Fairbanks, Alaska on 5 October 2023. The text can be used as a supplement to the slides presented at the event. The slides and a short workshop summary can be downloaded for the Task 32 website along with this document.

Significant efforts were made to assure the accuracy of the transcript; however, the readers are advised there could be misspellings and errors in the transcript.

SEBNEM MADRALI

Good morning, everybody.

Welcome to this expert round table discussion organized by IEA BIOENERGY task 32 Biomass Combustion group.

Today's session is going to be on bringing you some ideas and inspirations across from Europe as well as North America on strategies for reducing air pollution and learn about how the challenge of reaching out to large number of wood combustion users and how it's been tackled in other countries, this roundtable discussion is intended as an exchange of information, more a conversation between different stakeholders.

Why is there a discussion on this topic? Because combustion, particularly in residential applications, remains a significant source of air pollution in IEA member countries, and also there are different actions that are being considered, both on the policy side, for the regulatory agencies at state level, provincial level, territorial level and municipal governments to control the air qualities.

This event is in an online event. Our speakers, majority of them are around the table in Fairbanks with us. We have one speaker joining us online from Ontario.

This is going to be an event for two hours and we will not take any breaks during the two hours and we have 4 speakers. Each of them will be speaking to you about 20 minutes and we will leave plenty of time for discussion and exchange of ideas.

Towards the end, I will encourage you to use the Q&A box in your application to put your questions throughout the presentations.

First speaker, Hans Hartmann.

Hans is the German representative to IEA Bioenergy Task 32. Hans received his PhD in agricultural engineering from Munich University of Technology. He's currently the head of the Solid Biofuels department at TFZ, which belongs to the Bavarian government. The research scope covers all technical aspects of fuel provision, quality, combustion and emission controls. Hans is a member of a handful of national and international boards and committees and is author and co-editor of several books.

HANS HARTMANN

I hope everyone can see the first slide now and hear me also properly, so I say welcome everyone and I hope we can share some experience and information that we have collected and compiled within task 32, which I'm also a member of, and as Sebneim has mentioned that PM emissions and air quality is an issue, especially if we deal with wood combustion and that's what it is all about.

We think that everyone has good ideas about how to fight and to reduce those emissions from combustion. But not everyone probably knows about ideas and strategies others have; and the idea of this whole activity was to bring it all together so that we can learn from each other, maybe copy things, or criticize things and adopt them in a way that we find useful or necessary.

I think you may know that for particle emissions there is a good development in several regions. For example, in Europe, if you look at PM 2.5, you could see that in the last 20 years it has gone down to by 70% overall, but we all know that this is a success story that has not much to do with wood combustion, because this is all about progress in traffic and industry and all and so on. In wood combustion, we know, at least for Germany, it is true that the progress is much lower. So, at the end what we have is that the percentage share of wood-based emissions on particles will grow with the progress that is made in other areas. So, we must put additional efforts.

The IEA has created this report, which is online since last October, and you can all look into it. You can click through the chapters. My job is now to introduce you to this report, which is the basis of our discussion, and I strongly hope that at the end of this presentation you will feel encouraged to browse through the actual paper in full length. It's 100 pages with a lot of information and direct links to the sources that we have been trying to implement now.

The goals and scope I've already mentioned, is to learn from approaches that others have made in the field of emission reduction strategies in the task 32 member countries. It's Austria, Canada, Switzerland, Germany, Denmark, Italy, the Netherlands, Norway and Sweden. Italy has become a partner that provided information though it is not directly a member, but was kind to contribute.

So, the scope here is residential heating. Why is that the scope? It is because there the emissions are the worst and there the problems are largest. A vast field of activities and measures are concentrating on this because they are hard to fight and to reach out to all those individual millions of users.

The target group is decision makers, experts involved in abatement of wood combustion emissions, and it's not our goal to assess the effectivity of all those measures, as that is something very difficult and hard to perform.

In the study we looked at in total 15 areas. For example, the replacement strategies when the stoves or boilers are replaced, regional bans for biomass fuels as a means to fight emissions, tightening of general emission limits for biomass combustion or financial support schemes. There can be other indirect measures. For example, taxes, fees; building standards that want to inhibit an extensive use of stoves; boiler inspection, stove inspections, fuel or ash inspections can be done

and are done; forced shutdown of appliances; or particle precipitation devices that are tried and implemented on larger scale; catalysts. There are few certificates and labels try to tackle the problem of improper fuels; stove or boiler certificates are in discussion; specific information campaigns we found everywhere to use clean fuels and to apply them in a proper way.

Now let me jump into some of the examples.

What you see on the headlines are one of those 15 areas that we have investigated and what we did is every member country received an extensive questionnaire and there was always one question to each chapter that was preceding, for example, here: "Is there any regional or national replacement schedule of older wood stoves or wood boilers or does their permission expire at a fixed date or age?" And what we see here is the case in several countries; not in Austria, but it is in place in Canada, in Germany, Denmark, Italy, and in those countries, we have some activities on replacing stoves and oil boilers.

I'm just highlighting one example here. The example from Italy. In the Po basin, they have severe problems with air pollution. They have categorized the appliances into four different classes: two-star, three star and the four stars stoves. And then they said OK from the 15th of October 2018 on only two-star appliances maybe used or three-star stoves will have to be installed and then at a later date new installations will require four stars category. So that there is already a ranking of improved appliances being implemented in newly built locations.

Another example I can also cite from the report; for example, in Canada, the City of Vancouver has restricted the use of unregistered appliances in most urban area that would be in after 2025 and they need to meet special emission criteria and they have to register for that.

In Germany, there is another example. There is an obligation for a stove replacement if the recently tightened emission limits have not or will not be met, and that applies, for example, to stoves that are either older than 1975 or 1985, 1995 and 2010, and then there is a clear year for the replacement of those stoves that must be achieved, and it will be controlled and monitored.

In Denmark, for example, the replacement is triggered by the change of ownership of a house or a building, and that the stove was built after 2003. These are just examples of how such strategies are implemented.

There are many more measures. One that is applied almost everywhere is the tightening of emission limits, this of course is mostly done on national scale, but sometimes also on regional scale. We found that consistently the answer was yes to this question.

I'm just highlighting here one example, which is from Switzerland. You can see here the European Ecodesign Directive came into place in 2020 for all Europeans, so all countries had to fulfil that requirement. And Switzerland, which isn't a member of the European Community but has also decided to move from their old requirements for stoves, stove emission limits to the new ones. For example, just to give an example, fireplaces, earlier had a limit of 75 milligram TPM per cubic meter, and it had down to 40 as it is proven by type testing certificates.

You can see that there's a tightening, sometimes down by 50% of the earlier level and that has happened in all states, all member countries and of course also in Canada.

Another means of activity that can be chosen to improve the air quality is the inspection of appliances that can be either be stoves or boilers. We asked the question whether this regular inspection of stoves and boilers exists in the country. What you can see here is it was a yes for all for stoves, except the Netherlands. It was also a yes for boilers, except in the Netherlands. In some cases, it was not inspections that they're coming in on regular basis, but only if there is a case or if

there is evidence in some other cases, it's only for safety reasons.

When I received all those answers from the partners, I found the most advanced example is probably the one in Germany where the structure of inspections is very, very let's say, specific. We have for example 7500 chimney sweeping districts with minimum three persons working in. So, there's more than 20,000 people involved in the inspections and in the sweeping and the taking care of the chimneys as well.

So, what they do is in Germany, a regular stove inspection is performed by the authorized chimney sweeper. So, he will visit your place, will look at the stove, will check if there are any safety issues, if there are technical issues with the stove; if the rules are met. Fuel moisture is then also being tested, which you can see in the picture here. He's using this rapid testing device on three of those sampled logs. Poking at it in three locations, taking the average of nine measurements and then records the results. It shall be below 20% moisture content. He is also instructing the user.

Boiler inspections also made from 4 kilowatt and up, and here even measurements on emissions are done every second year, which is CO measurement and TPM measurement and that is then recorded and you have to pass otherwise they will show up another time or you have to bring in the maintenance team to your boiler. Inspection rules and owner instructions have to be followed. The procedures of what chimney sweepers have to are all written in a standard and there are five different instruments. I put the picture here that are approved for such measurements on site for emissions and well, that is quite widely spread and having so many people traveling around to those chimneys and operations means that there is a lot of, let's say, attention brought to correct operation of that stove.

Another point that I want to highlight is public financial support schemes. Why is that at all interesting if we talk about emission reduction by having a support scheme? You can ask for special properties of the appliances that you want to get funded. So those appliances that receive the support may be very advanced or should be very advanced. Otherwise, there would be no public money that is spent on your investment. When we asked the question whether this is happening for woodstoves, it was yes in Austria and Canada not in Switzerland. But yes, in Germany, Denmark and all the other countries, and also it happens for boilers.

And in the boiler area, that's also a success story, I would say, we had in Germany the MAP subsidy program for more than 15 years now, which has introduced much stricter rules than what was the legal minimum requirement. And by doing that, let's say, almost everyone wanted to receive those very generous fundings. So, they all bought those particularly clean boilers. We have now a bonus funding for boilers that are below two 2.5 milligrams per cubic meter emission of particles. And now the idea is of course, once we have those boilers on the market, they become the new state of the art. In the following, the revised legislation may probably only look at those boilers and will be excluding all others. This can be the result of such a funding program, that it has altered the level of quality of appliances.

Requirements for installing buffer storage were also tightened for those funded appliances. Bonus payments were made for retrofit ESP's, and also for condensing units. Also, for hybrid system combination with solar thermal. I would say the MAP was the trigger for the development of those low-cost ESP's and that now there is quite a number of manufacturers offering them and that there is a market for such technology. Also, the broad availability of condensing wood boilers in Central Europe is only due to this program. The manufacturers weren't happy at the beginning. They were just skeptical, but once knowing that the demand is there and the bonus is high, they simply had to follow and now every manufacturer that has some reputation, is offering boiler types with flue gas condensation.

Let me go on with regional restrictions and bans for biomass that is also very popular. It has

happened, for example, in Austria, in Canada, everywhere for the wood stoves and also for boilers, except in the Scandinavian countries and in Canada. Highlights from the report in Austria come from the city of Graz for example, where wood stoves were banned when the PM concentration in the ambient air exceeded the 75 microgram level over three days. Then, the ban came on wood stoves. We're not talking about essential heating, which is necessary to keep you warm if you have no other choices, these are called comfort stoves.

The boundary values were 50 microgram per cubic meter in the city of Bergen. In Norway, there was a ban on room heating devices that were older than 1998, and there was a ban for all open fireplaces, nationwide. In the city of Vancouver, we have seen temporary bans for certain calendar days. For example, during the summer months; no stoves are allowed between May and September. In the Netherlands, they had a "soft" wood fuel band. They call it a "stook alert". It's more a suggestion not to use the stove, I would say, because of critical weather situations. There is a spread of information, especially if you have registered on a website, it comes via regular email or other media. It demands that you will hopefully not use your stove in such critical weather situations.

Regional restrictions? Yes, many more examples that I could read here. In Geneva, City of Milan in Germany. And also in Denmark in special development areas of new houses, they cannot be built with chimneys anymore, so there's a lot of examples and ways to restrict the use of stoves indirectly.

Labeling is another issue, and it is quite promising in my mind. Labeling of products. In this case this means certificates for boilers and stoves. It is happening also in many countries, except in the Netherlands. For example, in Austria and Italy, with the "Aria Pulita", in Scandinavia with the Nordic swan ecolabel. For the stoves in Germany for years it was the DINplus label. There's now one new label which also introduces a new testing procedure which is real-life-reflecting. It is the "Blue Angel" which I think in the future will enforce quite strict and new limits and a lot of good properties of the stove. That means if you want to fulfill the Blue Angel, you have to have an ESP. You have to have a catalyst and an automatic air control, so that is the most advanced technology. That technology you can then ask for, and my guess is that in some municipalities they will, if they have problems with air quality.

Are there any public campaigns? That was a question we also asked. And yes, public campaigns on correct views are everywhere and in every country. Everyone has some kind of approach.

For example, Canada has introduced an online wood smoke course. The stove driving license to be launched next year, or teaching videos coming from Switzerland, quite nice ones. And Denmark: they have engaged celebrities to give instructions because they would probably raise more attention. Italy, they will advertise golden firing rules. Also, Austria has a citizen science trailer which was erected. There they demonstrate the use of a stove on a trailer in real life, as a roadshow, traveling to the cities to attract people to learn, while they stand next to the stove. Actually, there are researchers, leading forums and online workshops for the public in Norway. And in Sweden they are using instructional videos as well. In the Netherlands they have these information packages along with the "Stook alert", so this is very popular. I could go on for hours explaining what other examples there are. All is written down in the report, so let me briefly conclude.

I think this report is a nice catalog of possible measures about how differently the measures can be implemented and you can pick what you like.

But an impact assessment was not made. I mentioned that. But individual members were asked from each IEA expert to list their top three measures. You can look it up from the report. My personal favorites are: inspection of boilers, stoves, fuel or ash. If you have a good infrastructure

and skilled people to do that and they have a mandate. They have to have a mandate to enter the houses, that is the case in Germany. Furthermore, the tightening of emission limits has been very successful. And also advanced stove certificates or labels. I do expect a lot more of that to come up in the future, and that will set new standards.

That's about all I wanted to present. The report will be updated in next year. There will be 2.0-version. And there will be a contribution coming from our US colleague, who is already working on it. Market surveillance could also be added as a new measure. I was thinking of it; that could be an interesting idea.

Thanks for listening, everyone.

SEBNEM MADRALI

Let me introduce our next speakers, Steven Hoke and Cory McDonald.

Their BIOS before we initiate and start the presentations.

Steven Hawk has worked in air quality going on 10 years, having started with the with the state of Alaska Department of Environmental Conservation. With the compliance team in 2014, after three years responding to complaints and monitoring permit compliance, he moved into a position as the PM 2.5 implementation. Specialists in that position, he worked closely with Nick Czarneski as he was the FSP AQ manager at the time, and together they were part of the team to discover the glaring deficiencies in the EPA Wood stove certification. After five years working in that capacity with the state, he had the opportunity to take a management position with the Fairbanks North Star borough where he is today.

Cory McDonal has graduated from University of Alaska Fairbanks in 2020 with a bachelor's degree in physics and a minor in mathematics. He joined the Alaska Department of Environmental Conservation as an environmental program specialist, beginning with the stationary source compliance work. He has since trussed transition to working full time, addressing local air quality issues and the implementation of the Fairbanks North Star Borough Non-attainment areas, PM 2.5 state implementation plan.

Welcome to both of you.

CORY MCDONALD

Thank you for having us.

We're going to try to keep this fairly brief as we go through because we have quite a few slides.

I'm Cory McDonald with the Alaska Department of Environmental Conservation. And I'm pleased to be joined here by Steve Hoke over at our local borough partners.

A quick bit of background US EPA issues what they call the National ambient air quality standard and that is the level of in this case PM 2.5 pollution that all regions of America have to be under; the current standard is 35 micrograms per cubic meter. We were designated as a nonattainment area in 2009 and we are now in serious nonattainment area. Our issues, you know, we have wildfire issues, but we don't focus too much on those because those can't really be controlled. But the primary concern for us is those winter periods from October through March where extremely strong temperature inversions in the area are frequent, and it greatly exasperates our problems.

Here's a quick map of the Nonattainment area and extends throughout the city of Fairbanks and then also the city of North Pole. That's also part of the borough to the bottom right here. I think it's

important to understand that the Fairbanks North Star borough covers just over 7000 square miles of land. This portion of the borough is very small, relatively, it's but a small fraction of the actual Borough land.

So, you know the first question that came up is where's the pollution coming from? There's a variety of sources, mainly home heating oil and the stationary sources like the power plants. But the more we looked into it the more we realized that really the vast majority of the issues are coming from residential wood burning and wood stoves, and to a lesser degree, pellet stoves. Here, you know, in Fairbanks, we see temperatures down to, especially in North Pole, we see temperatures down to 60 below from anywhere from a couple days to a little over a week, sometimes stretching to two. I remember back in the 90s we had some pretty cold stretches because of those steep temperature changes and the lack of building code in a lot of the borough. A lot of these houses are not built to a standard. That kind of cold with just one source of heating. What ends up happening is you get these stoves that get into a house, and instead of being supplemental heat, they become primary. So, you have stoves that burn for 24, 48 hours or beyond 96 hours at a time.

As we go through this and we start talking about what was done in the area by the borough and the state, we're going to rehash a lot of what Hans talked about in the ways we approached it.

So, you know, the primary exacerbating issue is the environmental factors I mentioned before that we have temperature inversions and they are pretty severe. You can see on the right is a picture of Fairbanks during an inversion, and you'll notice all that fog at ground level. You can see that flue gas from powerplant stack kind of goes up and then takes the right angle when those inversions happen. It's like putting a big pot lid on top of the whole region and it just traps all emissions there and really right about ground level like the first 20 feet or so. We do have so in order to detect when we're getting the pollution issues, we have to monitor the spread throughout the area. There are three state regulatory monitors as well as a number of community monitors, some of which are located in managed by the borough and some of which are just owned by members of the community. So, the borough runs 11 community monitors in which we set up for both, to assist the state with their compliance of the SIP. So, the state implementation plan, which the state of Alaska is required to do by the Environmental Protection Agency to assist with that and also inform residents when the air quality might be less than good.

And we have made progress. So, you can see here there's a couple trends over time.

The top isn't Fairbanks. We could see that originally in 1997 the standard was 65 micrograms per cubic meter, but since in 2006 it was lowered to 35. Fairbanks, if you look along the right edge here, it's really right about at the standard and sometimes under it. But North Pole still has a way to go. Back in 2012, it was at 160 micrograms per cubic meter, and we've dropped that by about half.

How to reach the standard? We're really going to have to drop by about half again. So, getting it down there, there were a couple of obstacles we ran into; a lot of it was a social and some of it was habitual. People are used to burning wood, it became part of their lives. It was not just a way to heat their homes. It was internalized by them and therefore convincing them was the problem. And that's why the air quality was bad, was what was a stretch a lot of campaigns. Media campaigns were used in order to get people on board with the idea that there's a problem and we need to solve it. But that took time and years of work on the Boroughs.

And so as one of the major control measures that we have is that we implement specific heating device standards beyond even what EPA has in their certification program. Ours is more stringent and we have a number of requirements for all devices.

Primarily, if you look for what's those in pellet stoves, they have to be EPA certified and two grams

per hour and beyond even that we review reports ourselves, the test reports and we only allow devices that meet our standards of certification review beyond even EPA standards.

Other standards that are came into effect are much like Hans talked about that there's real estate measures that require the removal of a device that doesn't meet state and EPA standards at the time of property transfer, rental and any kind of property interaction essentially. As well as any device that just doesn't meet the standards. There's a new regulation in place by the state of Alaska, but that by December 31st, 2024, all devices that are either not EPA certified or over 25 years old and over 2.0 grams per hour will have to be removed by that time.

And you know, this really has been a story of trying something. It's not getting us the reductions we liked them to be reduced. And so, these restrictions have very much tightened as the years have gone on.

It's been sort of a stepwise process, and currently there's only a small section of stove devices, so the state has approved 15 log stoves and 30 pellet stoves for sale within the Nonattainment area. Each certification report is individually reviewed. Both, the EPA standards, and then also to meet our own standards as well. When this whole review process started, we have started to notice systematic errors and the testing and certification process implemented by EPA. And it's part of kind of a big investigation where we looked into it, and as you can see here; here's an example of some of the findings we had. That green bar represents the value that the EPA certification indicated for emission rate and the yellow and red is what independent testing of the same methods found. And so, we were finding that the methods were really not indicating properly what the actual emission rates were. And so, when you have programs like changeout programs where you're spending, you know, public money to change devices out and you're not seeing the reductions that you would expect, you start to notice, well, OK, are these stoves that were replacing them really better than what we are taking out? And that's when we started to implement our own approved list on top of what EPA has, in order to help them and on top of that, I mean, I think this is really a great slide.

So, the green bar there is the EPA certified level of emissions from these stoves. So that is what they're being sold as being marketed as, and what the reductions are that we calculate from our changeout programs and for our state implementation plan.

So as these changeouts go through, as we're removing older, dirtier stoves and replacing them with cleaner stoves, newer stoves, we are expecting those reductions and putting them into our calculations that we submit to the government.

Now what ends up happening is, as you can see, the orange bar there or yellow depending on your screen. That retest was done using the owner's manual, so that's as if the stove was being ran in a home. And some of these are two, 3 or 10 times higher than the actual certified values, which really just means we didn't get any gains.

All those emissions reductions that we calculated are not actually materializing in our monitors in real time, and it's worth noting that these non-catalytic devices are the worst offenders; the catalytic devices, so devices with the catalyst are closer to what they're supposed to be to what the EPA certification value says. But they're still not there. Additionally, we do have a real estate requirement that requires removals that Steve mentioned earlier with non-certified and devices that are older and emit above to have current per hour.

Another of our big efforts is burn bans, so we use that monitoring; the monitors that we have spread throughout the area and in a combination with what real time monitoring and what our meteorologists sees for weather forecasting for inversions. When we see PM 2.5 concentrations reach 20 micrograms per cubic meter, we call an alert asking people to stop burning. There are

waivers available for those as a stimulating circumstance, so if you don't have any other source of heat, if you're an economic hardship, there are waivers that will exempt you from the burn bands. But that is a step we take and in fact we have enforcement teams that go out and drive around, and we'll send letters and, you know, pursue enforcement on those sweet fact, violating the curtailments.

And then additional measure we have is dry wood. So, we require that all wood sold commercially has to be below 20%, and in fact they have to split three pieces of wood per cord. Measure the moisture content and record it and then submit those forms to us so that we can verify that they are meeting the moisture standards and for the drywood program with the state. I actually ran it when I was over there and kind of put it together for him. Basically, how that started was a voluntary program that rolled into a required program where wood sellers had to register and submit forms with moisture contents for wet or dry wood, and then they're in 2022. The dry wood requirement started where now in the Fairbanks nonattainment area, the only wood allowed to be sold is dry wood and this specific requirements on what dry wood is. It's below 20% moisture content as well as having records that that wood was dried for six months for mechanically or mechanically through a kiln, which we have one here in town.

And then the final, actually the project that gets us probably the biggest reductions, is the Borough's change out program. You know, despite the issues with the EPA certification program that we mentioned before, we do still get pretty good reductions from it from the changeout program. A lot of that is because, like I said, we do our own reviews and hold it, so we have a higher standard and what we allowed to be changed out is more stringent. And so that has helped us. You get reductions and then also moving to other sources. Maybe you could tell.

STEVEN HOKE

This is kind of my realm so I when I moved over to the Fairbanks North Star borough, I took over for the CHANGEOUT program.

So, when 2015 we started, the borough stopped, not stopped, limited severely limited the amount of wood to wood changeouts or solid fuel, any kind of solid fuel and went strictly to manage emergency backups, net propane, anything else electricity, I'm pretty much any other cleaner device.

Just recently we've added the oil to gas program to start eliminating home heating fuel boilers and getting them on to natural gas where available in federal funding.

We've been granted about \$33 million over the past 13 years and we spent about \$17 million on change outs and that number is continuing to go up and it's, you know, it's monumental the amount of gains that we've made in some ways. But at the same time, it's come at a cost.

You know, this is really kind of a story of a partnership between the borough and the state and the federal government. You know, originally the borough was implementing a lot of these programs, but there's a community vote that led to it being transferred over to this state.

And so now it's kind of big communication effort between kind of all levels of the government here to make sure moving forward. I think within the Community there was kind of a battle between two sides, right? You had the wood burning community. Who says, you know, this is our right. We have a right to keep our homes warm and keep our family safe. And on the other side you had the folks that were like, well, I have a right to clean air. It was the struggle to find a balance and what ended up happening in 2018 is that there was a consensus among a large portion of that community that thought that if they voted out the borough and the borough was no longer doing enforcement and compliance, that it would go away. Well, that's not how things work. It was just shifted to the

state and so now the state has the responsibility of compliance and enforcement. And that is the end of our presentation.

SEBNEM MADRALI

Our next speaker is Steven Law with Ministry of Environment in Ontario.

Steven Law is a licensed professional engineer in the province of Ontario with a Bachelor of Science degree. He has 25 years of professional engineering experience in Ontario and has worked for the last 13 years at the Ministry of Environment Conservation Parks as a renewable energy engineer within the technical Assessment and Standard development branch.

STEVEN LAW

Good morning or good afternoon wherever you are. I guess in Alaska, but it's good afternoon here now in Toronto where I'm currently residing.

So just by way of introduction, what I'm going to do is I'm going to introduce the group here today to a new guideline that was just published in Canada about two years ago. What I'm going to do is I'm actually going to open up my Google browser and share that as my screen and walk everybody through where to find the document.

Because I often joke the number one question that I get about the CCME guideline is where do I find it. So I'm going to navigate through my Google browser to show everybody how to find it, and then I'll put the link to the document in the Team's chat so everybody can have access to it later at their convenience.

But Sebnem really asked me to briefly introduce the back story of how did we get here to this guideline? So, there's a couple of key points that I'll briefly discuss before we launch into the guideline itself. Firstly, Canada does not have a well-structured national framework for the quality of air management, from small solid biomass combustion systems and boiler systems, and that was really a challenge for air quality regulators like myself. I mean, to be honest, it's one of the reasons why I left my private practice to come into government years ago, was because of the deficiency of standards, air quality guidelines and regulations, for biomass boilers. I mean, that was really one of my driving motivations is that I wanted to solve this, this challenging problem and I've now done that. So, it was actually my work in the province of Ontario that came first. I actually wrote my own guideline in the province of Ontario first. Subsequently, the Canadian Council of Ministers of the Environment, or CCME, reached out across Canada.

Very coincidentally, right after I published my guideline in Ontario and it was actually the province of British Columbia that was struggling because, as you saw in the previous presentation by our other colleague from Germany, the City of Vancouver and other jurisdictions across the province of British Columbia were having a terrible time trying to manage air quality from biomass boilers and residential wood stoves, et cetera. And so that's not the only instance across Canada. We had many instances of municipalities being left to struggle to manage air quality because there was a lack of support at the provincial and national levels to deal with these problems and that was really a gap that needed to be solved. That would be fixed. So like you say, because we actually have a CSA or Canadian standard for residential wood stoves and often on the larger industrial size, let's call it greater than five megawatts on the industrial and utility side, we generally have regulations, the specific gap that we were looking to fill with this project was the small commercial multi residential institutional size range, coincidentally where EN 303-5 perfectly fits that size range of equipment where in Canada we simply did not have a standard to manage the design operation and air quality of these small scale boilers. So that was a standard that I had studied and then I had adopted into Ontario. And then again, of course, because Sebnem and I both sit on TC-238 for

biofuels, we were also very much known to each other and we were collaborating on how we can, you know, use the EN 303-5 standard in Canada.

So having some of that background, I think you'll see when we open up the guideline and look at it the way that we structure the guideline was very intentional by including standards both international and the European standard EN 303-5.

And we also, as you'll see in a moment, we also introduced a tiered approach because that was the main thing that we realized when we began surveying the provinces and territories across Canada is that some provinces had more sophisticated air quality management regimes that would, like Ontario, suit that strategy well, but in a lot of especially Northern Territories and smaller provinces without a lot of engineering resources, they really had nothing. And they really needed something simpler to help them get started.

I'll now show with your approval, open up and share my window with my Google browser and start taking everybody through the navigation screen of where to locate the document and then we'll look at it together.

So, we're going to start with CCME resources. So, we'll click on CCME resources and then you can see there's many different options to pick from. So, we're going to pick from air quality and then within air quality, we're going to go to a QMS. And then within this screen it's the very top one guidance manual for air emissions for small solid biomass combustors.

So of course, you can download it at your convenience, but I'll put the link like I said a moment ago into the chat so that you can access it directly at your convenience. After the presentation today.

This is the Canadian Council of Ministers of the Environment. This is the guidance manual on managing air emissions from small solid biomass combustors, and it was published 2 years ago in 2021, so there's some introductory material here.

This preface is really valuable. You can read it at your convenience, but again, like I say, it's really focused on the size range between about 50 kilowatts of thermal up to five megawatts of thermal multi unit residential, commercial, institutional, maybe some small light industrial applications.

The focus was on applying ISO 17225 standard series, grades A and B for wood pellets, wood chips, wood briquettes and so on.

We did not include agricultural or other biomass derived fuels and then within the document, not only did we create this tiered approach of different levels of sophistication for air quality management regulators but also decided to divide the technologies themselves into different size ranges, so we've got those up to 150 kilowatts again, which are much obviously smaller, just barely above residential. Those between 150 kilowatts and one MW, and again, that's really where the EM 303-5 standard is.

So, like I say, up to 150 kilowatts in Canada, we've got the CSA standard B 415.1 and potentially the use of EN 303-5. And then again, the next level up, EN 303-5 actually serves that purpose very, very well. And then above 1 MW, we generally have mostly custom-built boilers for which we have no proper standard, and again those units, those larger units are generally regulated at the provincial level, not at the municipal or city level, and then again lastly, like I said a moment ago, we offer a tiered approach.

So, we've got Tier 1 generally more suitable for rural and northern communities with low population densities. And again, those are designed for air quality regulator regimes with little or nothing on the books at the moment.

And then we've got Tier 2 to more densely populated areas or those with sporadic air quality concerns, which is more typical.

But we also wanted to include a Tier 3 for larger urban agglomerations or for larger metropolitan cities experiencing significant air pollution issues, like the City of Vancouver. So again, this is really a national guideline with something for everybody, whether small cities, large cities, small, you know, stoves and boilers up to, you know, sort of commercial light, industrial size.

And you see here on Figure 1, where we've sort of summarized these different sorts of scales and applications of sizes, different reference standards and also as well you saw this in Hans' presentation like that, what types of emissions are more typically regulated.

So, this is one that I really learned a lot when I was doing my research about 8-9 years ago was the use of CO not only PM and that was something of course, as a combustion specialist I was accustomed to using CO as a critical pollutant to monitor for combustion performance. So, I jumped at the chance to include CO in my guidelines and regulations and Ontario to manage our quality from small biomass boilers. But at the residential scale, we often only focus on PM.

So here we have our table of contents. We have some appendices with some helpful information. Glossary and acronyms everyone's probably familiar with those units and conversions, and again of course, because we do have some references to American references in here, we do also have some BTU's and other.

US customary units in addition to our metric units, PSI obviously is one that we use quite frequently in Canada, even though it's a US customary unit. When we talk about pressure, et cetera, these key principles, this was one that we really spent a lot of time on. And this is where we've seen a lot of people picking up and using these principles in other documents. So, this is a really useful, I think opportunity for others.

Potentially even outside of Canada to learn from our experience here in developing this guideline, because this was an extensively consulted process where we really brought in a lot of different people and a lot of different perspectives across the country.

So, minimize impact of air emissions from small solid small biomass combustors on human health and the environment, of course, our PM 2.5, enable consistent Canada wide use of clean small biomass combustion technology. And again you heard me say this a moment ago, one of the things that we're struggling with in Canada is the lack of consistent standards across the provinces and territories. So, this is something that we really wanted to focus on was providing a more consistent application of standards. To make it easier for service providers, whether they be manufacturers or consultants or other professionals in the industry to use the same equipment and the same methods in each province and territory, that was a real problem that we wanted to try to solve here. And then, bullet #3, support the implementation of standards for small biomass fuels and combustors to minimize air emissions. So again, items two and three really kind of go together around implementing standards and then harmonizing standards across Canada, countrywide and then lastly, of course, enable GHG reductions by fuel switching because in Canada, we still use a lot of fossil fuels for heating our buildings, whether it be natural gas, propane, fuel oil and so on. So, fuel switching from fossil fuels to renewable fuels to reduce greenhouse gas emissions is a key problem. Again, that we're trying to solve here in Canada. So, OK, so here we have our introduction background, which I've already kind of spoken to a little bit.

Scope and limitations. So again, we've got the aspects that we've addressed here, equipment type, equipment size, sector of application, fuel types, these are topics that we really wanted to cover in a way that again just like my work in Ontario, one of the reasons why I wrote my guideline the way that I did and one of the reasons why I convinced the CCME to write this guideline in the

way that we did was because there wasn't a lot of in my opinion anyway, there wasn't a lot of good information, four other provinces, territories and municipalities to deal with in their jurisdictions that was accessible. And when I say accessible, I mean reader friendly and yet still technically competent. And that was something that I was struggling with. The fact that I found information was either reader friendly but not technically competent or highly technically competent, but not terribly user friendly, and that was something where I think this guideline does a good job of bridging that divide of providing information that is technically competent and reader friendly for a nonexpert audience. And again, like I said, that was something that I felt was needed. So here, like you, you heard me say earlier we decided to break the document into these different tiers.

Tier 1, Tier 2 and Tier 3 depending on the level of sophistication and needs of the various provinces or municipalities with that are using biomass combustion systems within their jurisdictional borders, and again the use of standards was something that we really focused on because that was a problem.

Again, we in Canada, we really hadn't done a terribly good job of adopting standards for these technologies outside of CSA B415 for residential wood stoves. That was really about it. So, like you say, the use of wood fuel standards, EPA certifications EN 303-5, this was really a big step forward for Canada adopting these modern standards for biomass combustion systems. So again, fuel standards, you heard me speak to that a moment ago. This is the first time in Canada that we have any proper recognition and regulatory reference outside of Ontario. Anyway, of course, where I began this process to cite in literature the use of these 17225 standards which have been adopted by Canada back in 2015. So, we're a little bit behind the curve compared to our friends in Europe, but we're making great progress over the last number of years.

So here we have this table showing the different standards for appellants, chips, briquettes, etcetera. I won't get into all this because this this obviously information is covered elsewhere and can be read in detail at your convenience.

Model testing and individual on-site testing, so again we get into third party lab certification like you heard in the presentation immediately prior. Of course, that research into the American testing and certification was very much part of our research in developing this guideline and so on and so forth. So, we have the US EPA, wood heater rule, et cetera referenced here.

For everyone's point here, like I say, my goal here today was not to give a detailed overview of the guideline proper. It was really to introduce everyone to the guideline. Let everybody know that it exists a little bit of the back story, the implementation of standards. And like I say, breaking the guideline down into different size ranges, small boilers, package boilers and then larger custom units you know was something that we really wanted to do and that we were successfully able to do that.

And then again, because of how the environment is regulated in Canada, it's actually regulated at the provincial level, not the national level. So again, just for everyone's clarity, this is a guideline, not a regulation. And this guideline holds no legal force until it is adopted or cited by the individual provinces or territories. So really the hope is that the individual provinces and territories across Canada will recognize this guideline and adopt it into their own environmental regulatory programs at the provincial and territorial level.

And again, that was really the problem that we were trying to solve here is that the province isn't territories lacked the engineering resources to write this kind of a very specialty guideline themselves.

So that's really where this opportunity to come together with regulators such as myself across the country, put our heads together and come up with this program for the individual provinces and

territories to adopt at their convenience where they might otherwise, like I say, struggle to craft such a guideline where there might be limitations on budgets or engineering resources and so on and so forth.

SEBNEM MADRALI

Without further due, I think this is a good segway to introduce you to our next and last speaker, David Dubois.

David is bringing a different perspective here. David has been in the biologist sector at different capacities for many, many years. And he's a chemical engineer by training from University of Alberta in Edmonton. He currently works as the manager of Business Development for Fink Machine. This is one of the leading commercial biomass boilers and in Canada since 2017. Previous to that, he was the Chief of Engineering and technical outreach specialist for the Community Energy Association, where he worked from November 2015 to April 2017. During this time with the CA, he worked with local governments, educating and developing policy around building energy efficiency, energy and emission reductions, as well as a variety of renewable energy projects. Before that, he worked developing a biomass heating sector in British Columbia as the project coordinator for the Wood waste Rural Heat project. And during this time, he has looked at completed two dozen feasibility and pre-feasibility studies on potential biomass heating projects. He is also leading the design and development of a second-year bioenergy course for the Lakeland College in Vermilion, AB. He still teaches this course, and in addition he has edited a variety of guides and advisory documents. He is also a counselor for the village of Cache Creek in 2014 to 2018, and he was re-elected in 2022.

DAVID DUBOIS

As Sebnem said I'm the manager of business development stating machine. We are counted as largest supplier of commercial biomass boilers. Through that work, we do a lot of engagement with a variety of different levels of government, and I'm blessed enough as part of my work to be engaged and do a lot of work with standard developments with the CSA 415 standard as well as some of the TC community on biofuel.

I kind of bring a little bit of a side to that and then on my personal side, I'm a counselor for the village of Cache Creek, which I'm sure many of you have never heard of unless you're looking at the natural disasters we've had over the past eight years, we've been in the news number of times because of wildfires being evacuated, flooding, et cetera. The town is about 900 people, but we're indicative of a rural community in British Columbia and across Canada that are experiencing a number of challenges as we go forward.

So that's kind of where I come from in terms of wearing these hats and because of that, I'm able to sort of see both sides of the table, both in terms of communities that are on the forefront of implementing bioenergy projects.

Obviously, my lens is coming from the commercial scale project, not so much on the residential, but because there has been so little commercial development in the sector. We see a lot of times that we are being targeted with a lot of the same issues and comments from the residential side, so there's not a clear distinction. So, I just want to go over a couple of things to kind of set the stage for my discussion.

I think when we're looking at communities, you know, we see some general drivers from biomass, there's the economic side of it. People looking into reduce their energy costs, reduce waste or their environmental side looking to reduce their fault or sorry, lower their greenhouse gases.

Waste utilization, kind of a differentiation between waste reduction if you're somebody that produces the waste and has to get rid of it, you want to be able to utilize it or reduce that waste or if you're utilization as a community, what can I do with that material let's say that's coming into our landfill and then increasingly what we're seeing is that communities are interested in the economic development side of biomass and increasingly energy security. So, the picture that you see on the right there is, I just want to point that out, that's the water plant for district energy system in Yellowknife that was installed. It's got four clients connected to it. It actually won the FCM or Federation of Canadian Municipalities. One of their sustainability and energy awards, I believe was in 2019. So, I think this is something where you see municipalities are really interested in going forward and they can be a catalyst for driving these projects forward and some of the key drivers that they're looking for are the cost savings from their reduced energy consumption.

But beyond that, there are also looking to develop economically within their communities. They're looking to identify how they can support forestry that are present in their communities and how they can help to diversify those businesses. In addition, they're looking to reduce their greenhouse gas emissions, as I talked about before, waste reduction and resource utilization and increasingly the one that we see as being an issue is going to be wildfire mitigation.

The system, the picture that you see on the right, that is a small system up in the Belfort delta up in the northernmost part of Canada, that community has an ice road only to access community or by barge. So these communities are important because these are the communities that are really on the forefront and one of the things that we see is that local governments have the ability to impact 52 per 60 % of the GHG's.

That number is specific to BC, but energy costs and availability also can have a significant impact on local economies. For example, we have many communities in the rural context that some are on diesel generation, which is number one issue. But we even have grid tied communities that are typically on the very end of the line. So, they're often experiencing brownouts. It's very difficult for new industry to start because there's not the additional capacity electrically to start up.

In addition, communities are most directly impacted by the impacts of climate change. When you hear about flooding in communities, you hear about wildfire going through communities. These are all things that are potentially I believe actually are impacts of climate change and it's our communities that are on the forefront of that. So, in the picture that you see below, there is I mentioned Aklavik. This is a project at a school just to let you know I'm not participating in that. This is a project at a school where we actually had to take the boiler plant and put it on stilts. You can see the cribbing underneath it because the permafrost is melting and it's no longer stable enough. So, we had to put that on a system that could be adjusted to maintain it level as well as make sure that we're not having heat from the boiler plant penetrating down into the ground. So that's a real climate change impact that we're seeing right now in the development of these types of projects.

We see that again with wildfires as well. You know, we see communities being impacted as our forest dry out. We have these extreme weather events. All these are happening and so these are all things that local governments are keeping in mind. So that to set some context from within Canada, I'm going to start from sort of some broad things and tunnel it down a little bit.

Within Canada, we have urban context and we have a rural context and the urban context, generally speaking, these are very large organizations. They have tons of capacity to do development work.

I think we heard referenced a couple of times the City of Vancouver what they're doing with air regulations. They have the capacity to develop and implement those types of regulations as we get to the more rural side, it becomes much more challenging in many rural communities. You're lucky

if you have some form of bylaw enforcement. Typically, it's a stop or I'll say stop again and there's really not a lot of teeth that they have to implement any change. So, when we talk within Canada, most municipalities have very little control over what's going on in their environment. Typically, the local governments are doing roads, they're doing water and sewer, they're doing garbage, they're doing Fire Protection. And really, that's about the only roles that they have. They can influence land use policy, but anything beyond that is only powers that they choose to take for themselves. And oftentimes, communities are so capacity challenged, they end up not doing a lot of that. So, when we look at these large urban communities, they are very divorced from where their energy comes from. It's a light switch. It's a thermostat on my gas furnace. Whereas in the rural context, because of the availability of the energy, the instability of it, they're much more aware of it. They're much more connected to it. So that's where we see a lot more of the bioenergy and the wood fuels coming in and usually areas where there is no natural gas.

So, when we look at developments within the urban sectors, from bioenergy, it's large scale. It's multi MW plus scale whereas on the rural it's much smaller. The urban projects are being driven by I'll call it the environmental benefits of lower greenhouse gas reductions. So, they're doing it at an industrial scale. So, what's the implications are completely different. It's a different regulatory scheme when you're doing it on the rural scale and the smaller centers, it's much smaller. It's the 100- or 200-kilowatt boiler capacities that we see. So as a result, the projects are being driven by economics, with the side benefit that you're having a little bit of cake because you're getting some GHG and other emission reductions there.

And I just want to clarify, within the Canadian context, there's some generalizations across the country that I think are important to keep in mind when we look at cross Western Canada, there's a lot of natural gas that this penetrated into the market to a wide variety of people. So natural gas is an energy source, is very cheap in terms of context. I'll throw a number out there of \$8 to \$10 to give you jewel or about \$0.03 a kilowatt, four cents a kWh when we start to progress across into the central part of Canada, we still see some natural gas and a little bit more of a shift towards electricity until we get to Quebec where there's a widespread electrical penetration once again very low cost in the range of 6 to 7 cents a kWh for that energy source. As we get to the maritime provinces, it's a little different. The maritime provinces don't have a lot of natural gas penetration, so once again, we're seeing the opportunity for the use of wood in heating applications and everything that being more prevalent.

In an urban setting that you would not see a wood combustor or a wood stove as a primary source of heat in a metro region in Western Canada, it's very common to see in Eastern Canada because they don't have the natural gas. So, there's a there's a little bit of a difference there, so that when we're looking at that from a government point of view, how that's going to impact. So, when it comes to biomass and these types of heating systems, we're in a little bit of a challenge because the municipalities have the opportunity to be an early adopter, to be a catalyst towards good clean combustion and adoptions of systems. But on the flip side, they can also be gatekeepers. Oftentimes they're being inundated by comments from people that are concerned. As the speakers from Alaska mentioned that they don't want to see anymore combustion, there's a negative perception of it.

And then there's also issues of locations. Where can we cite these? Where should we be citing those? And the challenge is, is that in rural governments there is a lot. They don't have a lot of knowledge and the capacity to gain that knowledge. So, they're relying on documentations and standards that they might not understand. So, for example, when Steven mentions the CCME guidelines, that's something that local government could implement to help do that. The challenges a lot of this documentation is being heavily influenced by NGOs that have a very specific agenda. One of the ones that we're seeing now is that we're seeing NGO's trying to influence some of these things and saying, OK, we want to go towards electrification of everything. And in the urban context, that works really well, in the rural context not so much.

The other thing that we see happening is we see confusion because there is the lack of capacity. There is a lot of knowledge. Often times you'll find contradictory messaging coming from the local government. As an example, many of you may know the city of Prince George and the interior of British Columbia. At one time it was home to one of the largest pellet plants in Canada. It was one of the early adopters for production of pellets and it's kind of a hub for, I would say, that for probably 203 implementers of Prince George, there's probably 1.5 million tons of pellets being produced, at the same time the municipality outlawed pellets for heating in their community. So, you have this ballot plan that could not even put in the pellet stove to heat their own building is a thing. So, we see that there's a lot of contradictory things happening and that's typical for small local governments because we don't have the capacity.

There's not always a good analysis, and you have these outside forces constantly pulling back and forth and it sounds really easy. We're just going to update your bylaw. But when you look at this context for rural local governments, they oftentimes have multitudes of bylaws that are often from the 80s, 90s. I know from our municipality we have some bylaws that I look at it that are still in the old lithograph machines. That's where the bylaw is held to even have an electronically. So when you factor all those things in together, it becomes very problematic that to try and do this, and that's where having some of the documentation things like the CCME guidelines are important. I think that from my point of view, having the CSA guideline and the E303-5, for the folks that don't know the EN303-5 is a European standard. It governs both the physical characteristics of the boilers as well as the emissions of the boilers. Within Canada we have one boiler regulations for the safety of the boilers and we have a second one, CSA B415 that was just recently updated, It aligns with the EPA guidelines to look at what the emissions should be. The challenge is that what we're trying to do is we're trying to legislate manufacturers to reduce equipment when, as Alaska has shown, it's really about the implementation of that equipment and how it's being utilized. So, the ability to do education, is really some of the key for local governments, but it also relates back that whole capacity issue.

I want to talk just a quick little thing about the Northwest Territories. It's a region in the northern part of Canada. I'd like to say that it's a huge territory. Physically, it's huge, but it's about 40,000 people, so it's something that I think could be a catalyst and be representative of a community. Yes, it's a very wide community, but in terms of the capacity and the ability to develop and what they've been able to do is they've actually as a community integrated 40 biomass heating systems over the past number of years, variety of scale. But they've really flipped the switch and created a culture of support.

Now everything that they're doing is based on pellets, simply because they don't have any kind of large-scale forestry around them. They still have people that burn wood, but the trees grow very slow and everything like that. So, what you see there is a variety of different projects where they're doing it, but it's an indication of how a local government can start to shift the dial by using their own infrastructure to kind of create some of that. What they've been able to do as a local government is that their expenditures are 8% of their energy expenditures are coming from wood ballots, but their total energy consumption from wood pellets as a percentage is huge. It's about 20% of their energy usage, so you can see that there's a real benefit to them. And I think that that's something that local governments are aware of and want to shift towards. And the key is that if they're able to do that on a commercial institutional level, then I think it the case is how do you translate that down into the smaller systems, into the residential.

And I think what they they're doing is they're laying the groundwork to say we're moving away from this old mom and pap model. I've got my wood stove and I'm going to use it as much as I want and I don't care what you tell me because all you can do is tell me to stop and then say stop again and I'm going to do whatever I want. This creates an atmosphere that people are going to be more informed and hopefully more sophisticated.

So that's kind of sums up my presentation. What I want to sort of put out there, I'm happy to answer any questions, whether specifics or generalities, that being part of a local government and how we look to implement biomass emissions, work into the on the ground deployment.

SEBNEM MADRALI

Thanks all for participating.

I think we heard quite a wide variety of approaches and perspectives around this. And that covers not only from the residential wood stoves, but also getting into the wood boilers, that are relatively new for North America, I would say; but also the differences between emission performance of these equipment.

I believe we have some questions on the on the Q&A, maybe we'll start it off.

CHRISTOPH SCHMIDL

There are multiple questions coming to our colleagues from Fairbanks. There's one from Sean coming to Cory and Steven: How do you measure the PM levels, reach the thresholds? Do you use small sensors or just the official monitoring stations?

CORY AND STEVEN

So, it's actually it's a mix of both. So, we have three regulatory monitors that are run by chemists who work for the state of the Alaska, and those are the primary monitors that we look at to measure real time particulate levels. But there are also several a number of community sensors that are smaller and scale spread throughout the area. Some of them are collocated and I believe managed to a degree by the borough and there's also a number of them that just used by members of the general public are better information available.

CHRISTOPH SCHMIDL

Question by David Dubois: What is the percentage of capital funding for the change out program? What is the percentage of a purchase of a different device or just what those numbers are?

CORY AND STEVEN

So, there's no real percentage. It's based upon the back and forth with the EPA in the state, as far as like how much we fund. So, you get more money for a bigger reduction. I think the current time for the replacement to gas. So, if you're going for, let's say a wood outdoor hydronic heater to gas, it's \$14,000 that you can get through the change out. If you're removing it, you also can give \$14,000, but some of our other options offer less money, but that's the max. And then from like a wood stove to gases, \$10,000 to go from oil to gas at 7500 and it kind of gets lower for the less PM reductions.

DAVID DUBOIS

So let's say if you go from an older stove to a newer certified stove, what kind of subsidy would you be looking at? What would be the capital cost to actually do that swap on?

CORY AND STEVEN

I believe it is 6000. Let me double check that I have it right here in front of me.

DAVID:

What would be the capital cost to actually do that swap on?

CORY AND STEVEN

That seems like it would be like a 50 to 75%.

It's actually 4000 like that. So, but probably 40 to 50% of the capital cost of the swap.

So, I went through the change out program twice now, once in 2011 with my first home and back then it was. It seemed like it was less. It was two or \$3000. I don't remember which, but the cost of the stove was only \$2000. I don't think I paid a thing. There was no requirement to have it professionally installed back then, so that wasn't required, it was a way to avoid that extra cost. Now, with the state's current regulations, it has to be professionally installed. So that's extra cost. So, if you buy a stove for \$4000, you're probably going to pay 8 to 10 with it installed in the context that I've seen with various local governments, offering would still in Canada, typically that wood stove swap out for wood to wood is in the range of 250 to \$500, it's significantly less.

DAVID

So I think you guys have done a good job in terms of figuring out an amount that would actually be a true catalyst rather than just absolutely a lot of time has been spent trying to figure out how to incentivize the program and get people on board with it in a way that feels meaningful to them.

CORY

Also, we are looking at upping across the board all of our incentives here in the coming years, just because of inflation.

DAVID

What is the percentage of people that are applying for the waivers? Is there any trend that you see?

CORY

So, our percentage of that are applying for waivers I think is relatively low compared to those who I think could apply in our capable of getting the waiver. Some of that is the red tape you have to jump through the application is about 12 pages long, you have to gather, so there's several forms that they have to fill out.

So, our other adequate source of heat waivers that allow you to burn no matter what level of curtailment we do have two levels of curtailment depending on severity.

DAVID

Those are bit more stringent.

CORY

It's not.

Just look, I have a new stove. It's cleaner than the other ones with the device waver. You have to make the case that I need to be able to burn whenever and here's why. So, you have to decide a technical issue with your home. You have to decide that it's your only source of heat, or you have to prove some level of economic hardship which will be done through a number of assistance programs.

There used to be more waivers when the borough is running the waiver program. I think they had upward with 100 waivers when they started. When the program got transferred to the state, the process became more onerous and so we saw a huge drop in the number of waivers in the area. So, like I said, it was the borough was over 100 when it came to the state. We were looking at more like 10 to 15.

DAVID

Did you say that having that more onerous application is a bug by designed actually discourage those that are maybe on the margins?

CORY

I think that it was more to ensure that those who were getting the waivers actually were qualified, but they were actually the people we were looking to help. And not just.

I will say that I think it as far as trends go, I think you can tie it fairly directly towards the perception of enforceability, kind of like you were talking about, you know, if the community thinks that we're going to enforce the regulations and enforce the burn bans, you know, if they receive a letter in the mail telling them that they've been identified as burning during curtailment, they are typically more likely to contact us about getting a waiver.

SEBNEM

With regards to the test methods and the differences in the certification results versus what you have seen in real life. And I think European colleagues could also comment on that around the table.

I wonder whether I could open that discussion a bit more and we'll talk about some of the certification tests and your results, but also maybe Christoph, if you could also talk about the ongoing are in the activities with beReal project and they follow UPS on that for the test certifications.

HANS

Yeah, real life testing is something that we are following over the last many years together with all of the Institute of Christoph and others we were trying to implement a real-life test cycle on European level that also includes all the critical phases.

So that you would at the end have the total operation and picture will be complete and not taking out selected batches and using the best ones you can get and then displaying it on your certificate and hoping that no one will ever retest it.

But yeah, that has been very difficult because industry wasn't very interested in that because they would know then probably that they would have worse results while the emission limits need also to be adopted to the new methods.

So that was probably the whole struggle, but I believe we need methods that tell more about the reality. For example, the Blue Angel certificate that I just mentioned. It was based very much on the beReal study that we had made. It also includes the two first batches that run in natural draft, including the cold start. It has a partial load phase. It has seven batches in a row. You cannot do a selection of the best. So, it's already reflecting real life.

But then what I think is, we need retesting, and when I saw your results with those bars, you know you're retesting so dramatically higher, 10 times higher I guess in some cases, I thought you had the

same problem that we have. We get appliances on the market that are not the same ones, that are not the same quality as the ones that have once been tested before market introduction. Recently we got a study from Denmark. I reported it yesterday. We do have evidence that the retestings, even if you look at the existing standard, which is not real-life reflecting, will often fail.

We had this study from Denmark last week, 15 appliances bought from the market without asking the manufacturers were retested, and 82% of them failed. So, I would say we have to introduce some kind of threat towards the manufacturers that they should fear a retest, even if it is using the one test method which is not so much real life reflecting.

They should know that if they change the product or the quality of the product, its specifications during manufacturing in order to save money and yeah, to be cheaper, that will become visible by such efforts. And I think it's coming up in Europe now that institutions are built, that are only there to retest appliances in homes.

And I guess it's wise to put in money because there's a lot. Even in our test lab, sometimes we get stoves that are destroyed after one use. They're not airtight anymore. We wonder how they could ever have passed the certification test with those features. So, I guess we need more pressure on the manufacturers. They are selling rubbish sometimes.

CHRISTOPH

Let me to answer this is the reason why the Ecodesign Directive, the European Commission, has now implemented those markets available, so we have implemented thresholds but also foresees market surveillance of all products.

So this means they will be taken from the market, not from the manufacturers.

It will be serious products and they have to fulfill the same requirements as they have been tested originally, with some the additional amount, but I think this is necessary and once this is in place it at least causes a threat to the manufacturers so they are forced to sell the products as they have been tested in the original testing cycle.

Also, this European project and testing standards be real and I'm the Austrian representative in this IEA BIOENERGY Group on task 32 combustion.

MORTEN TONY HANSEN

And I wonder whether you could continue on that comment and maybe give it more content on the results that you have seen.

STEVEN HOKE

I mean, it is a topic of conversation that me and Cory have had many times with our colleagues across the United States at this point.

We are trying to get the federal government on board as they are the ones in the United States that regulate the community of wood manufacturers.

The issue being is that for the past 30 years, they've had regulations in place and just didn't do anything.

And so, you know, we've there OIG report. I would encourage all of you to look it up. It was based on all of our research with the stove certification testing, right, org being the EPA, Office of Inspector General.

So that was a big internal investigation that they found severe deficiencies in the compliance and enforcement program for the wood stove certification testing.

But based on our research, and so I mean really, I mean all the points Hans made, I mean it's you have these test methods like you know United States we have M28R, it's using crib wood or just regular 2 by fours, 4 by fours in order to simulate a burn. Nobody is at home burning 2 by fours or 4 by fours. We're burning cord wood. They had the 3053 method ASTM 3053, which used cord wood, but they didn't really regulate how that cord was prepped or prepared. So, you see cord wood where they have debarked it where they have shaped it into a shape that works perfect for their stove, you know, going on the long lines, we're talking about prototyping. So, you end up with these prototypes, stoves in the test stand running the certification tests. And as they're testing it, they're adjusting it to make it past the test. So, I think the issue in the United States was a lack of oversight, a lack of clear standards.

And then also kind of passing the buck.

So, what you end up with is the process is supposed to be the manufacturer develops the stove, sends it off to the lab, the lab, an independent party, tests that stove and it passes or it fails. It gets sent back to the manufacturer and then the EPA would get sent at that information. They review it, give it their stamp and send it on.

But what ends up happening is the manufacturer pays a laboratory to take this stove, goes to the laboratory, helps the laboratory, helps them make a passing stove, and then the EPA doesn't look at the data and just puts their stamp on it and kicks it off.

And then you know, it's local communities that suffer with these stoves that aren't doing what they say they're doing. And when you're trying to get out of nonattainment and get clean air, it's just not conducive to that goal.

SEBNEM

This is very interesting discussion in terms of the equipment performance, but early on, not only as part of the task 32, but early on in the conference that we heard Hans made some comments on the importance of the user impact, especially when it comes to the woodstoves. And I believe you also have some experience in Austria looking at the impact of the users on the actual emissions.

CHRISTOPH

We will come back to that question. There is one more question that is linked to the to this, it's he's asking on one years of his life to say during forced the rules and stopped the selling of noncompliant appliances. And the question is, how did you manage to stop the sales at the point of sale? Or is it in the building permit or on the state level? So how was that done?

CORY

So it's state regulations that affect at point of sale.

So it's specifically vendors.

So yeah, stores were selling devices to local areas.

STEVEN HOKE

I can speak to that a little. I was in in that role when it happened. I spent a lot of time at stores. I spent a lot of time going into stores looking at their inventory, going through and telling them, hey,

you can't sell this. Hey, you can't sell this if you don't want to be in non-compliance and get in trouble. You better get it off the floor.

The problem we ran into is a lot of these big box stores selling things like US stove, Lennox, things like that is they don't control their inventory, the inventory gets sent up from the lower 48 States and so that they were kind of in this battle.

It took a year and a half before I was able to actually get people to figure out that they couldn't sell these stoves. And I saw something about camp stoves. I don't know if that was the same one. We never actually stopped the sale of camp stoves. There's no EPA regulation regulating camp stoves and the sale of camp stoves, so we can't regulate it because of political friction. Was at camp still camp stove is not defined clearly, so our best bet is just like a mobile stove. So, we need to put in a side of a tent or something, and that was part of the issue, we had people claiming that these big 300 pound stoves were camp stoves and I was like, please pick it up, put it on a sled and touch, you know, drag it out to your cabin and we'll see how camp it is, you know.

DAVID

I'm just curious when you were going to the retailers and saying, OK, if you're going to be putting it into the Bureau, you can't.

CORY

You can't sell it, but what about who was policing to say that? OK, I'm going to buy this. Was it the vendor that was responsible to ask the question? Where are you going to install that? And if the answer came back in the borough, sorry I can't tell this to you or was it just flat out? No, you can't have anything that's not approved for sale.

So, at the time of sale, the device is required to be registered, if the device is not going to be registered, a form has to be provided where they would fill out the form and say in the customer would test this device is not going to be installed with this nonattainment area and they have to put down their address and whatnot.

So, it was kind of A and that was supposed to be submitted to the state.

CHRISTOPH

OK, then let me comment on your question on user influence.

What we did is simply testing which are the influencing factors on emissions from wood stoves like in Germany Hans presented yesterday and in most of those investigations we found out that even the user influencer used the operation influence is much larger than the technology influence. And our conclusion was that we have to go beside the technology strengthening, sharpening the limits we have to go into user teaching, information campaigns and what we found out is that going to the users, it's a trailer, they're going around in the villages and cities, teaching them on the clients. It is even better than just online campaigns or leaflets that you put it to operation, it's learning by doing, they will have the emission measurements with their stoves and they see if I make that mistake, what does that mean for the emissions?

And we hope that that helps. But of course, the question is always how long does it help? Will they come back to the old habits or will they take these messages with them, but to our feeling once they experience, I'm able to have effect or lower emissions, then efficiency is going up. they will keep that user operation and I think the driving license for stove operators like Hans mentioned, is going in the same direction, teaching, teaching that's it. I come in that having to teach people to operate their stoves properly.

HANS

There's also the technological approach. If you introduce automatic air control, you can avoid many of those operational errors. The ones that I presented on the conference was, for example, that you do not forget to adjust the lever of the air from the gate air by moving it to the window purge position, if you just forget to do this, to adjust the stove, you will have like 5 to 6 times higher emissions. But that would be done automatically by the stove itself and this is 100 % abatement of that problem. Also, operational errors can be avoided, not at that degree, but just to say, technology can also help you at least halfway of avoiding those user impacts with a low-quality stove when not automated. There, you will have a high bias between best and worst operation.

DAVID

I think that's a great point and kind of on that note, and you can see that with pellet stoves, we also have done some testing on pellet stoves, and the difference between the tested value and the retested value are a lot closer than with wood stoves. The issue you run into then is with automation usually comes electricity and in places like Fairbanks we're at the end of the line and you have one power grid powered by one entity. I mean when the power goes out, how do you keep that going?

When I put my local government hat on, and we talk about doing an education program, that sounds fantastic. How do we pay for something like that? Is that funded by the government? Is that funded by the stove producers as manufacturers pay?

What I think it's great to have that idea, but I think practically who funds that? Who, who can be on the ground, because, you know, doing an education program like you're talking about, that's going to require a lot of hand holding one to one time.

It's not something that a lot of groups are going to be able to say.

I'm going to be able to coordinate, you know, 15, 20, 30, \$40,000. When I look at my municipality, of 900 people are total tax base is \$850,000 plus. We'll get other grants, but that's what we generate from tax revenue from land taxes and everything like that. So, having an understanding of how something like that would actually be implemented I think would be a very key point of discussion.

CHRISTOPH

It's one thing to have a program, but how you actually pay for it, it is something I think would be good to be part of that discussion. The provinces are responsible for air quality and in this case, the Austrian province of Styria, the region where they had air quality problems, decided that this would be a good idea and finance such a project, so it was on the province level then in this case. So, it was not the City of Graz, because it would be too high funding or financing. So, it was the whole province that put together the money and it was several €100,000 that we spent over several years on that.

STEVEN HOKE

Majority of campaigns that have been done within the interior have been funded by federal dollars.

The United States government, that there's been some by the state and some by the borough, but the majority of the money that's been put into education and outreach is coming from federal grants.

SEBNEM

Any comments on the education side which you see in Germany?

HANS

I'm just make sure you're willing to bring up another point, on the quality. Is that possible?

That was when you both presented the way you treat the fuel provision of log wood fuel, and the quality of logs. When I came to Alaska and saw the climate here, I thought, wow, how can they ever dry the fuel to the point that it needs to be dried down to. But then I heard about your approach that the dealers themselves need to get certified so that they guarantee that whatever is being brought to the end user will have the proper quality. I think there's a great approach. In every country where we have problems with air, with stoves, we all think about what to do about the wood, in our case, we do have these inspections by the chimney sweepers. They come and look at the at the fuel too.

But you what you need is a thread that people who have the wrong fuel will get punished by that, and also illegal fuel like you know, waste and waste wood, painted wood, whatever, that is in a way identified.

But I was only to ask you what happens with those people who go to the forest themselves and claim some wood. Is that allowed?

STEVEN

It is allowed. You just have to hope that they do it right.

We can't go into somebody's house and take a moisture meter and check their moisture content of the wood. There are, I believe ranks that require that you have to use dry wood. But the enforceability on that isn't quite there. I think.

What it really comes down to is like an education campaign to say, look, not only is it better for the environment to use drywood, it's better for your wallet because it's the heat efficiency and the heat that you could get of wet wood is not the same as what you get out of drywood.

Yeah, it's a mess.

So we started the drywood campaign back at 2016, 2017. It was voluntary. We had a number of registered wood sellers in the area by 2018 and had thinned out a little bit because it was then required and I was out testing wood stands. Fire kilns stands just everywhere. I was testing all the wood sellers to make sure it was under 20% and so the more we regulated, the less sellers we had, the less available wood was then. When the regulations came in 2022, that required drywood sales, all of a sudden we only have one seller and all the other ones just disappeared.

But they didn't disappear. I mean, they're still selling, right? I mean, like people are still buying wood and then so we had one wooden kiln open up the Aurora wood kiln which has been great but their capacity is not nearly what it needs to be.

I think it's currently at 4000 cord. And that we had that first year we had calls to the governor and to everybody that they could get a hold of saying there's no wood. What are we supposed to do? You guys are regulating, but now we can't heat our homes because there's no wood. And so it, yeah, it's been an adventure.

It does look like Aurora is actually going to be giving a presentation about their kiln that four. So

those of you who are interested look forward to that.

SEBNEM

There have been some links to interesting publications and I think we can include them in on our website afterwards.

CORY

I actually had a question or comment. I heard a lot of you from Europe and I'm very curious as to we had an ESP test here. Do you remember the name of the brand? We had an ESP test come up here where the local electrical utility sponsored a bunch of houses to get an ESP installed.

And I'm just curious how the ESP's work in Europe versus here. Here we found that they clogged very quickly. And that they started chimney fires. And so I'm just curious as to how that played into woodstove use in Europe.

It's my understanding that woods stove heating in Europe is mostly supplemental, single room heating and not so much for whole house heating. For instance, my house is 2200 square feet. When I moved in, there was a big wood stove in there and that thing could heat the whole thing for days. So I'm just curious to hear your feedback on that.

HANS

We talked to someone on the conference, about the same issue. And I was quite surprised to hear that chimney fires were brought in, associated with thoughts that it had to do with the ESP itself.

I'm not sure why that can happen. If the chimney gets on fire is probably not well maintained. Also, if you accumulate a lot of tar and a lot of particles and soot over, a fire can come, but that means that you probably need to have better maintenance of the chimney in general.

And of course, with an ESP there's much more particles falling down until the basement, the base of the of the chimney. We have very strict rules about chimney sweeping. They come according to the amount of fuel you use per year, so the chimney sweeper can decide between once or four times to visit your place. He decides, not you! You have to pay. So, he decides how often he has to do that and if there is a clean chimney. It wouldn't happen so much that chimney fires can come up, but of course, yes, the particles are in the chimney. They are posited at the bottom of the chimney. On the other hand, by better and more maintenance of the chimney, this can be avoided. We don't have these problems.

STEVEN

I was very surprised about hearing that the ESP could be the reason for such fires at all. From my understanding these houses were chosen for this testing the ESP, they were cleaned previously to the installation. So, by a professional. And then the ESP was installed and then the professional would come back every few months and what ended up happening is in between those few months between cleanings it went off and started a fire. And then the whole, the whole project was scrapped as it was thought to be too dangerous to continue. And I think the thought behind it was that as it was collecting particles that it collected too many particles.

ESP's are effective. They're using industrial sources all across the United States, and the practice is sound, right? But if they work, the problem is the cleaning regime, and you make a good point that you know when it's set and it's done by the professional.

HANS

I think maybe the issue was you know how often do you clean them when the stove never shuts off and what is the temperature of your flu?

Maybe you're heating too high temperatures and efficiency of the stove is not so good, so you have excessive temperatures and with the soot layer inside of the chimney you get that those fires.

It's probably also a problem of older stoves I would say, and of the fuel that you put in it.

CHRISTOPH

I think it is a mixture of different topics. ESP's are working, if you are maintaining your chimney and cleaning your chimney regularly, there shouldn't be fires.

But of course, if you have a lot of particles, you have high temperatures, maybe some glowing particles are going into the chimney, then there is a risk of fire.

SEBNEM MADRALI

With this, I would like to wrap this up.

This was definitely a very interesting and engaging discussion.

I do appreciate for all the speakers taking the time and being in here.

I also thank for all the participants who join online across the world.

As I understand, we at registration-wise we had 50 plus people and I don't know how many have joined us.

I also wanted to thank and give a big shout-out to Alaska Wood energy conference. They have been great partners for us in the previous last couple of days.

I would like to particularly give thanks to Karen Petersen, who was a great partner for us and help us to make sure that we are here and be able to put this out together, and all the logistics. With that I would like to wrap it up.

Thanks again and have a good day everybody.