Res1: Welcome to the ME-NET early warning network project, which is led by Dr HM, from Lincoln University and is supported by her colleagues and also at Lincoln and here at the University of Ghana and all of you. Firstly, our gratitude for saying yes to our invitation to join this stakeholders advisory board meeting. I always love it when we have stakeholders advisory board meetings, when we have a committee of expertise of people who have the experience and expertise to guide research projects in a way we are able to co-design and co-develop and co-implement whatever projects for research that we want to do. And that is why we are here today. The ME-NET Project, is to look at the relationship between methane emissions and health, right? If you look at the climate change narrative, a lot of the things that we see, or a lot of the literature tends to focus more on carbon emissions. Meanwhile, methane is also one of the dangerous pollutants that we need to pay attention to. And I think this is one of the pioneering works on climate change, specifically looking at methane. But what we want to do is see the links between people’s exposure to methane emissions and how it affects their livelihoods, their health and so on and so forth. So one of the overarching goals of this project, beyond engaging stakeholders, is trying to know what the data is saying and writing our reports and publications. We want to also leave something with communities, with the people that we are working with. And so we want to go a step further by developing an app and maybe also a website or something, whichever suits, and see how people go into the app, test their exposure to methane, and then for instance - Where is the nearest health centre and what can be done to deal with the methane exposure? It is on this note that we have contacted you, some of you we've met in person, to bring you on board to help shape the goal that we have. J and J are experts in machine learning and all of that. H has expertise in climate change, just as I am here. But you don't want to do things like researchers. You are on in the field in one way or the other, either in health or in the energy space, you have different expertise. And we want you to critique and to be the second eye, to WhatsApp we want to bring out so that we can contextualise whatever we have developed since we need our input to be able to develop an app which will be relevant and that will reflect Ghanaian contest. So the essence of this meeting is to introduce you to the project briefly and then we will have a discussion. Just feel free, bring your lived experiences to bear, share your experiences with us and guide us as to how you think we can execute this project. So I think we can go ahead and introduce ourselves. This is going to be the agenda. <Discusses content> we've had the Ghana stakeholders meeting, and maybe I will invite H to say what are the key things that we need to say during our introductions? I think you asked about methane and our expertise?

Int: Yes, thank you so much for that introduction, and also for your time and travelling and getting to know people, all the work that you have done on this project, it is really amazing and made it possible. We have met once now with our Accra group. We have another meeting with them coming up in a couple of weeks. The first thing that we did is a bit of a get to know you, we ask people to introduce themselves, tell us about themselves. Actually, because there is a smaller number of us here, we can hear about what you do and where you're from, and maybe what you see is your connection related to the environment on this project around methane and health. We also ask people to tell us what they think of when they think of methane. We asked our colleagues in England, what they think of, and they just said cows! Cows and methane, you know? That was really useful for us because it taught us a bit about how they think or maybe what their experiences are linking to methane. But I'm sure with colleagues in another part of the world like Ghana, there might be different things that come to mind when you think of methane, it might not be cows, it might be cows, I don't know. I haven't met any of you before, so I will introduce myself to start. My name is Dr HEM, and I work at the university of Lincoln. I don't know if you can tell, but I'm not English, I am from Australia. I moved over here in 2018 from Australia, and I've been working at the university since then I'm really interested in climate and health. So the impact that climate change is likely to have on the health of populations is something that I spend a lot of time focusing on in my research area. I'll tell you a bit more about this project in a bit, but to say that I didn't really know anything about methane before I started this project. When I thought of methane, I thought of a bright orange gas for some reason which turns out to be really uninformed, methane is clear and transparent and not orange it's all! I clearly didn't know what I was talking about when I started this project! I might pass on to E?

Res2: I will start by saying that I am a civil engineer and urban environment and climate change specialist. I work at the Secondi STM, Metropolitan Assembly as an engineer, and I do a few urban management practices together with engineering. The engineering is more about the urban management system. My idea or a few things that I know about methane gas, is that they are pollutants. They have an effect on the environment, polluted environment, the air quality through some gases from waste management systems, and also fuel from energy. I think for now, I will speak on the energy and the waste. Then I think I must have begun to know that the bedding of the fossil fuel and all those things also have methane gases. I don't have much idea about it yet to know about the energy and the waste and other aspects of the methane gases, I need to research into that. I met Dr E, he is a brother and a friend. We move together for some time visiting places.

Int: Thank you, super interesting, you are an engineer. I'm sure you’ve got all sorts of lived experience that would be great to hear about through this project. I think the next person is F?

Res3: I am also an engineer, and mechanical engineer by first degree. And then technology planner with a second degree. I focus a lot more on environmental technology as well as my interest area. I've been doing a lot of environmental impact assessment, environmental management for the past 30 years. So I've had lots of experience of that. Yes, it's true that there hasn't been much focus on methane in terms of environmental regulation. Rather methane has been more with methane capture for the biogas projects. I got a little bit more excited about methane when I was on a course with Ghana Gas about processing there. There is a suspicion of significant escape of methane, especially when they are flaring, and they were discussing how we could possibly measure that. We had some challenges with the instrumentation to do that. I was then discussing with Ghana Atomic Energy, but they didn't have the facility to do that. So we haven't been able to push the project further, but I'm still a little more interested in looking at that to be able to see what levels of methane we're looking at and then be able to have a reasonable understanding of its implication to the environment and health in terms of the ozone, and then the human health as well; especially looking at its dispersion and then people settling within the areas high level ground concentration. This is something I'm quite interested to look at in the near future.

Int: Gosh F, I feel like we need a whole separate conversation, just briefly, I have been struggling to get my head around what data is available for methane, not just for Ghana, but for the UK as well. And unbelievably, the UK doesn't really regulate methane either. I have learned recently. I've had a lot of conversations with people in Defra, the Environment Agency, trying to understand what we do to regulate methane, and actually when it comes to the private sector like mining and energy and everything, and waste…. I feel like we should say hello to D, and just explain what we're doing. Hello D?

Res4: Good afternoon.

Int: Good afternoon and thank you for joining us. We got are just going through some introductions, some casual getting to know you’s. We have just heard from E and F, and I was just responding to something that F had said about his interest in how to measure Methane. So that's sort of where we're at.

Res4: My name is LD, I'm from Takoradi Metropolitan Assembly, the metropolitan officer.

Int: We are very pleased to have you with us. We're just going around and saying here we are, where we're from, where our interests are, and what we think about methane. I might just finish what I was saying in response to F, and then we'll move along, and you can introduce yourself is that OK?

Res4: That's OK.

Int: I was just mentioning that in the UK we have to keep track of methane emissions, but the way that we do that is actually by asking companies to self-report rather than there be objective measures for emissions, which is a little bit strange to my mind, but whatever. We have a data set which is based on the Copernicus Sentinel satellite mission, but what I have found out recently is that that data, not just the UK, but for Ghana as well, there is some data for Ghana for methane, but it's all dispersed in mixed measures. It's not on ground, it's up there. So for this project, we've been exploring all the options for trying to model ozone and forecast ozone for Ghana. Maybe we should chat sometime, it is hard to do, and I don't know if we can do it because all we have is the methane data from the upper atmosphere, we don't have on ground. But what I did want to mention to you was that we have a satellite. There's a satellite company called GHG Sat. I don't know if you have heard of them, but they do lower atmosphere measures of methane. So they do very, very granular measures in the UK. That's how we pick up leaks and flares. I am registered with their platform, and I can see them, I get emails about it from them, and it is crazy, the leaks and flares that go on in the UK are mad. You wouldn't believe it. They go on for months. So it's not widely known. And to my understanding, there are some satellites that GHG set has that cover Ghana. So I've asked them if we are able to access that data. They are a private company, but as far as I understand, they are happy to share their data for research purposes. So I will let you know when I hear back from them. I've emailed them again recently because they didn't get back to me. I think they have some archive data which might even be at the site level for Ghana. If they have that, I will try to negotiate if we can share that data. So hopefully that would be helpful. That's a whole other conversation that we could have, so I'll stop going on about methane now, that's my knowledge about it anyway. D tell us a bit about yourself? Tell us about what you think about methane?

Res: My name is LD, Metropolitan environmental head officer for Sekondi-Takoradi, and I environmental scientist. Methane is a gas that is coming out from open dumps and landfill sights, maybe wastewater accumulation and other release of emissions of such nature.

Int: We're just gauging everybody's experience with this topic. E?

Res5: My name is EA, I'm an environmental health analyst with Sekondi-Takoradi Metro Assembly. I am the landfill manager. When methane comes to mind, what I think of is the landfill because the landfill is a major contributor, but anything, especially open dump, which is more common in Ghana, especially where I am at the landfill site. You know initially there was provision tracking of methane gas from the landfills using the gabion basket. Due to some difficulties in managing the site, all those baskets have been destroyed. Now methane is just flying in the air because we don't have the daily waste cover, mostly it's done on a quarterly basis. So once the waste is exposed, decomposition is taking place, methane then is being released. Be fine also comes to mind other landfill food methods also come in which is for the <?cocoa?> method introduced by the Japanese where wet gas is supposed to escape. That is the pipes that are supposed to allow gas to escape, the method allows oxygen to flow through the piping system so the once the oxygen mixes with the methane, it produces carbon dioxide and water. You know that methane has more bonds between atoms than carbon dioxide. So once oxygen mixes or interact with methane, then it becomes carbon dioxide which is much less dangerous than methane. Methane also comes to mind when you are talking about the greenhouse gas, which contributes to global warming. So basically, that is what I will say will come to mind whenever I hear or we talk about methane.

Int: Thank you, sounds like you have a lot of experience in this area, so very pleased to have you on board with our team. You sound like you know more than I do anyway, which is great. And just finally I would ask our colleague J, who is a colleague of the university, to introduce himself. Now J has been asked what he thinks of methane more times than he can remember because we've had quite a few stakeholder meetings now. But J, please do introduce yourself?

Res6: My name is JA, I am from Ghana. I have been here a few years. I have a background in nursing, but I went onti tech federal training in primary care and public health research. So as H said, I am supporting her on this project. In terms of meeting, we have spoken about this a number of times now, but in terms of methane, I’m thinking about waste, I'm thinking about cows and gas. E has given us a lot in terms of chemistry, but this is what I think about when the thing comes to mind.

Int: I find it really interesting because obviously people's understanding of this issue in England is so different, and it's you know, I don't think everybody is even aware of the kinds of sources of methane that we have here, we definitely have issues with higher missions, but it's really not well known about; whereas talking to colleagues like yourselves in Ghana, it feels a little bit more like this is an immediate closer to home kind of issue. So it's really interesting to hear people's different experiences with this topic. So E and I had a brief discussion about what we're going to do in this meeting. E, I think we said that we might just go a little bit over some of the content that we did in the first meeting that we had with our colleagues in Accra. I might just talk you through some of the developments since then. We had an initial round of meetings with colleagues in England and Accra. And those conversations were really about how to start developing a health protection app. This project is the first step towards that app. We're just trying to understand what it needs to look like. Our funder is the Welcome Trust, There's a few kind of I suppose goals that we have to meet for them. But then we're also trying to figure out what the next steps would be for Ghana compared to England and things like that. So we had the first set of stakeholder meetings, and we got a lot of feedback from people about the way that we were developing the project. Then we've gone away and spoken to the company that we're working with who are doing their design and development of the actual app. Since then, they have made a lot of changes. So I'll go through the slides of the first meeting but just to be aware that there are some points in the presentation where we ask people for their inputs and what they think, What direction we should go in, how we should change the app. But I'm not going to do that exercise with this team today because we've already made lots of changes since then to the app. It would probably be better to talk you through what we did, how we did it and show you where we're at now, which is a little bit further along compared to when we first had the first meeting

<Displays Agenda for Today slide>

Int: The first thing we did in those meetings was the talk a little bit about the project. I won't go into too much depth about the project today, but you can read as much as you want about it when I circulate the slides. I'm going to tell you a bit about the process that we have been through so far. I did send a link for the ethics and consent form previously, but I will resend it in a follow up e-mail.

<Begins presentation and covers the following topics>

- Welcome Trust funded project.

- Brief Develop a dashboard to understand the impact that methane has on health.

- Prototype project for running 12 months (July 1st, 2024 – June 30th, 2025).

- Multi sector collaboration.

- A first step towards understanding the role that methane plays in health. Also improving access to health outcomes, improving access to health services for adaption, and providing opportunities to support research ecosystems in data scarce regions.

- Aims: the pilot an integrated data platform (ME-NET) for regions with varying environmental and health data availability and quality, and with varying sources of methane emitters and super emitters for a) developing data synthesis approaches that are globally applicable, and b) training methane ‘early warning’ models that are robust to regional contexts.

- Outputs: 1. Machine learning algorithms showing the links between methane, ozone and health outcomes. 2. Phone/web app for Health Protection, tracking the impact of zone on mental health and respiratory symptoms, and education in the UK and Ghana, and (including coastal sites).

- Research Questions - To what extent can deep learning be used to develop an ozone early warning system that incorporates health data into regions of the world with a) higher and, b) lower/middle income, reflecting wider global variation in data availability and quality? - What are the most relevant health measures for exploring physical and mental health emergencies associated with methane and ozone concentrations in the two regions, and is it viable to use DL to predict great server emergencies associated with air quality? - What user functions would improve the visibility of climate change impacts, and how deliverables are these, given data availability and quality in regions?

Int: It might be for Ghana that we need to use measures like particular matter, and air quality. What I’ve discovered since we did this presentation is actually we may have to use a different measure for Ghana, simply because we are not sure we can get accurate forecasting data for ozone. We're still working on that one. But that was the idea, to develop a phone app to support people's health.

- Four Main functions 1. Alert Me, 2. Explore and Learn, 3. Our Data, 4. My Profile.

<Displays Explore and Learn function slide and describes function>

<Displays Mobilising citizen science for global social and ecological justice slide>

< Displays My profile and Alert Me slide and describes function>

< Displays Methane early warning network slide and describes function>

Int: So that's where we started off with the project and we ask people to think about the material and give us some feedback about any potential red flags or unintended negative impacts there could be. So we have a really good data set from colleagues who have done this exercise before we start to think about what some of the challenges might be.

<Presents on Education Modules> as follows

* The Perfect Storm
* Ozone and Health

<Presents the Perfect Storm slide>

* Ozone occurs naturally in the stratosphere, making the earth habitable.
* Ground level ozone occurs in the troposphere and affects the air people breathe, drives global warming and produces health impacts.
* There are no natural sources of ozone in the troposphere, it is produced from interactions between emissions from human activities and meteorological conditions.
* Specifically, ozone is created when hydrocarbons interact with nitrogen oxides and sunlight.
* Nitrogen oxides occur when fuel is burned EG car emissions and commercial, industrial and residential emissions.
* Sources of methane and non-methane volatile organic compounds (Non MVOCS) include vegetation, waste processing, fuel production and combustion.
* Methane important because it stays in the troposphere for longer than other pollutants - up to 12 years - compared to less than one day to months for NMVOC's.
* While non methane V OCS are more reactive, accounting for a greater proportion of ozone production, methane is more abundant due to its longer atmospheric lifetime.
* Methane is also a major driver of climate change, with 80xs the warming power of CO2 background levels reflect cumulative build up.
* Methane and climate change are linked via a positive feedback loop

<Presents the Perfect Storm slide>

* <Shows image slides for Perfect storm>
* <Evaluation> take a couple of minutes to consider the people in your life who might benefit from the ME-NET application. Do you think the perfect storm module would be easy to understand for those people? Please respond to the brief survey items using the QR code.

Int: The slides are quite descriptive with quite a lot of text, it kind of relies on people’s understanding of the basic science, and basically everybody said to us that it is way too complicated for their communities. And also, it isn't really relevant to most communities, most communities want to know how something impacts their health, they are not so interested in the science, this can be really confusing for people, these images and this text. Pretty much actually everybody. J did some qualitative analysis of people’s feedback, and we found that these were common concerns that people had that it was way too complicated, it wasn't really meaningful to most people, most people are interested in their health. So we ask people to do a bit of evaluation, and then we started to talk about the impact of ozone on health. Originally, we thought it would be cool to have educational material and resources in the application, and the phone app, that would help people understand the impact of ozone on health. But actually, when we went through this exercise, people thought there was way too much information to deliver on an app. It could cause users to become quite anxious. So if we started talking about the impact of ozone on respiratory health for example, that seemed quite scary information: loss of life related to cardiovascular and respiratory illness, the impact on children’s breathing, respiratory mortality. People said that they didn't think it was the level of information that most app uses want to know, it's good for us to know, but it's not really helpful to most people. We also talked about the links between ozone and mental health, and we talked a bit about the studies, on the evidence base for impacts on mental health isn't very good compared to the evidence base for respiratory health.

<Presents ozone and respiratory health slides>

* WHO estimates greater than 7 million deaths per year from air pollution.
* Deaths attributable to ozone specifically during warm periods across Europe between 2015-2017 was > 100,000(Achebak et al, 2024).
* As soon as associated with approximately 0.7 million deaths per year, on average 6.3 million years of lost life related to cardiovascular and respiratory illness (Aneburg et al 2010).
* Long and short term exposure decreases lung function, particularly for children) Holm and Balmes, 2022).
* Peak daily ozone and ozone in warm months is associated with cardiopulmonary and respiratory mortality.

<Present Mental Health slide>

* Zhao et al (2018) reviewed 31 studies –> Links between ozone and cognitive function, possible links to suicide, depression to ED admission for panic attacks, notably:
* Two cohort studies showing association with depression, including increased risk of reporting symptoms per 10ppb ozone exposure, association with them being concentration and suicide mortality in Belgium for all seasons except winter;
* one case control studies showing difference in ozone for days with +2 suicides (x=86.4 ug/m3) and those without (x=79.8 ug/m3)

Int: Mental health research is less clear

<Presents Direct vs Indirect Pathways slide>

* Increasing evidence for direct impacts of pollutants on central nervous system, cerebral white matter, cortical grey matter and basal ganglia (Bernardini et al, 2020b)
* Alterations to brain regions and process is linked to psychopathology EG changes to neurotransmitters (Zundel et al, 2022).
* maybe some direct pathways to? EG possible links between respiratory systems and mental health flare ups/escalations. Biophysical effector blue inhaler salbutamol overuse EG increased heart rate, tremors, stomach acid precipitating anxiety?

<Shows some points to consider slide>

* WHO estimates that dangerous ozone concentrations are greater than 100 ug/m3.
* Thresholds might be low for mental health.
* What are the actual links, drivers and pathways?
* Much more research needed.

Int: People actually thought it was dangerous, and we shouldn't be sharing the information with most people because there isn't enough of an evidence base and it would just cause panic; which was a really good point. So we took them through all the sciency stuff, and people said it was too much information for most people. I will just move through some of the content.

<Shows Ozone and your health slide>

* Think about the most important thing you have learned about ozone and health. Which bits are the most important to include an educational module ‘Ozone and your health’. Which bits should be represented visually? <Shares mages designed by Lincolnshire’s University Academy Holbeach in Kings grammar Grantham students> Picture – How bad air things get out.

<Displays Follow up Survey Screen>

* - Find out more: your ideas about the links we should embed in the app.
* - Opportunity to recommend additional stakeholders for the board.
* - Days of the week/times of the day for future meetings.
* - Further opportunity for feedback and input.

Int: And then we ask users what we should tell about people about ozone and their health, and then what everybody seemed to say was that he just needs a really basic image that shows people about certain health, that doesn't go into all of this detail. This is just final the comments and we talked about future meetings. So that was our first meeting.

Res1: Dr P has just joined.

Int: Dr P welcome. Would you like to introduce yourself before we go any further?

Res7: Thank you very much and good afternoon. My name is Dr P, I am the Metropolitan Director of Health Services. My basic responsibility is to administer health in Metropolis. I'm in charge of health activities in the entire Metropolis.

Int: Thank you for joining us. I was showing the team a presentation which was the first presentation that we did with some colleagues in Accra. It was really how we got the first lot of feedback from people about this app that we are developing. So we showed some slides are design and development team, who are an NGO called Common Knowledge who are based in the UK, and they had developed some content. And really what the feeling was that the content was too complicated, it was too sciency, people wouldn't understand it. It was all about the role of methane plays in producing ozone. And to the fact that ozone is harmful for people's health. We discussed what kind of information we thought should be presented to people as an educational components of the app that we are developing. People said that really they didn't think we needed to go into a lot of depth about respiratory health and mental health, people just want to know what they can do to protect themselves. So we went away and we had conversations with our colleagues who are helping us develop the app, very recently they gave us some new content, they took on all of the feedback that people are given us in our stakeholder meetings and they went away and created some new content. That's what I'd like to share with you today, but E, is there anything else that you want to discuss before I move on to more slides?

Res1: I think you have highlighted all of the key things. I'm glad to know that based on the meeting that you had with the Accra, you are able to revisit how you want to develop this app with the machine learning team, which is very important. I don't know if colleagues have burning issues to clarify or you have something to add on what H has presented so far?

Res3: I would say it's been a bit more inundating, it is being very fast and I haven't been able to track, and I would be very happy to have this slide and then also be able to contribute more meaningfully to the issues that we're looking at, especially as to the amount of information that could be useful to people and how we could make it more interesting for people to find it useful, and then be able to use it as well. So I would like to do that subsequently and then make my contribution. But in other aspects, I'm wondering how we could because our regulation has not in any way looked at methane, how we could generate this data, because the government standard has no information on methane. And therefore, in all our environmental management measurements, methane has not been a concern; although there has been a concern of the emission of methane with greenhouse gases that is more being their concern with methane. And all the projects that have been done, the concern is more of capturing methane and using it otherwise for other processes. It will be interesting to know how we will be able to know how to find meaningful data to do this analysis.

Int: I apologise for moving so quickly through those slides. The reason for that is that we now have some new slides with different content which is updated. What I'd really like to do is show you the updated slides because that's the next step that we've moved on to with the content. So probably it will be more useful to get your feedback on the new slides, rather than the old slides. But I share your interest in trying to come up with meaningful ways to capture data. And then to find a way to communicate to governments. not just in Ghana, but in the UK too, to try to show what the impact of methane is on health. I went to a meeting recently with representatives of Defra. It is a government department, and I went to this meeting, and they said that they don't regulate methane because they don't think it has an impact on health. I said that we know that it does because it contributes to ozone. And they said – Show me the data. I said - That's a very good point, I can't show you the data, because currently I don't have it. And the problem is that when you look at ozone and you tried to say look for a relationship between an ozone data set and a methane data set, that would be a really simple way of showing that actually methane has an impact on ozone. We know that ozone has an impact on health, do something about it. When you try to do that, ozone data is on ground level, so it reflects what's happening outside, now. The methane data is upper troposphere, is not on the ground, there's no relationship between the datasets, that I can see, so we don't have an evidence base. This is something we are working on. I would love to continue that conversation with you because we need to figure out a way to do it, otherwise I don't think governments are going to regulate, I don't think they will.

Res3: See how it goes. I think one of the key issues will be method of measurement, how do we measure methane? As I said, I discussed the project with Ghana gas so that we could see how best we could measure the methane, the unbanked gases and then we could model to see dispersion, so that we can see how far it goes and where it's settling, for Ghana Gas, to see whether it affects the community. It was a project that we were looking at. The main issue, like I said earlier, was that Ghana Atomic Energy did not have the means to do the measurement. We were discussing to find an alternative. We haven't found the alternative yet. So the project is still under consideration.

Int: I have some colleagues who work in the private sector with technological solutions to measuring methane. So I'd be happy to introduce you. It's not something I know loads and loads about, but I do know quite a few people who are working on technological solutions for on ground measures. Would that be useful?

Res3: That would be very useful. Very useful to me. Then I can pick the project up again, thanks.

Int: We can have that conversation another time. So we showed our colleagues the content that you have just seen. But then our design team went away and made some pretty big changes. So I'd like to show you now the changes that they have made and to get some feedback from you about this. Something that we're very aware of is there a design and development team have produced this content based on their knowledge and based on their understanding. What we've talked about is that a lot of the images in the text and the examples are very European. They are the sorts of images that might be very easy to understand how people in the UK, in Europe. And actually, we had a meeting on Monday where a colleague joined us from another university and he's a professor of respiratory health, but he's also from Ghana. And he said – Honestly, this content is really good, but some of it wouldn't be suitable for Ghana, so how could we make it more useful for people in Ghana? I said that's interesting because actually we're going to show colleagues in Ghana this content, and we'll be looking to get input and feedback on what the content looks like. So that's what I'll show you now. This is the updated content. I might limit our discussions, there is a bit of content here that we might not have time to discuss, I might put it in a separate e-mail to you.

<Displays personality matters slide>

Int: This was a little extra activity that we did. Something asking everybody in our team to consider, is their positionality. What that means as researchers, and people in industry, government and healthcare, everything, we have our own personal experiences, and we bring those experiences to the table when we engage in research. So we've asked people to fill out a short survey to tell us a bit about them. The reason for that was that in this meeting we started talking about self-reporting, how people could tell us using an app about their respiratory health and their mental health. So we thought it was important to consider the experience that we have with respiratory health and mental health to capture that to help us understand the team that we are working in.

<Displays About you slide>

Int: So we had a brief survey which I can circulate after asking people to tell us a little bit, completely anonymously, about the lived experience with health. I've had a look at the data, quite a lot of the data from our colleagues in the UK, and lots of people say that they have had experience as carers or with other people's respiratory health. And then a lot of people say they've also had experience with their own respiratory health. So we have a few of my close colleagues have been asthma sufferers their whole life and this means that when they look at this content, they're coming from a point of having lived experience about respiratory health. So that was something that we did.

<Displays Methane Early Warning Network Slide><Displays Main Feature (Refresher) slide>

1. Register a user profile including health conditions, demographic characteristics;
2. Set alerts, up in for push functions, for ozone in your area to receive recommendations for Health Protection;
3. Receive prompts to self-report daily respiratory and mental health outcomes health outcomes including text/visual scales (e.g. Emotion wheels);
4. Advanced option for setting bespoke thresholds for alerts (e.g. If particularly susceptible to us from attacks might lower threshold for Health Protection recommendations.)

<Displays Main Feature (Refresher) slide>

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<Displays Your Suggestions Slide>

‘A picture tells 1000 words’

* Education Model: start with simple picture-based image we've touch animation guiding user attention to links between health, sources of pollutants and environmental/metallurgical condition - > fed back to CK;
* Outcome: CK will adopt an ‘agile’ approach, users are guided through a simple module with options for ‘find out more’ boxes with backs, and additional links to ‘find even more’ – 3 tiered.
* Self-reporting health and well-being:
* Outcome: we will give users the option of both numeric and picture-based reporting, but we need your help to Co design and trial the visual material!

<Int:> I mentioned the main suggestions that we had from people about the last content was that it was too heavy on words. There were too many words, and the words were too science heavy. And they suggested that a picture tells 1000 words, and that it should be using more images. They suggested that we should start with a health message rather than diving into the science of ozone. And F, I would be interested to hear if any of this feedback is similar to what you were thinking. Any of these comments things that you also thought because it was pretty unanimous that most people thought these comments. So start with a simple image and make it really clear what the health links are first. Start with health rather than starting with ozone or methane or equations or anything like that. So we went back to our design company and they introduced us to the idea of an agile approach. And that is where the users of the app are guided through a really simple image, and then they have the option to click and find out more. Then they get more of the science. So we all agreed that we like the content that was presented last time, but maybe it was a bit too much, now we should start with something simpler. If people want more information, they can click on ‘Find out more’ and then some content from the last presentation would be available to see. When it came to – Ok, I have received an alert about ozone, and now I'm being asked about my health was today. The feedback that we've had is that some people might want to use a quantitative scale of one to ten about their health. They might want to type some texts explaining about their health. But other people might actually just want a very simple image or a symbol to help guide them. Some of the colleagues from Accra group, are respiratory and mental health nurses, and they said that they thought for some of the patients, using a numeric self-reporting system that's very quantitative and data-driven would be quite off putting, and they would rather have smiley faces, something that they could see is a little symbol that they can press, rather than loads of text. So that was the sort of feedback that we gave to the company. So the company suggested to us that they can give users of the app an option. So when you're setting up your profile, actually you could select – I would like to self-report my health using a scale, like a scale of one to seven. And that scale would be based on text. So we could say something like – I had trouble breathing today. To what degree do you agree with this statement on a scale of one to seven? You know, that sort of approach. Some people might like that comment on some of our nurses said that actually carers might like that, so if you're caring for somebody that's very ill, it might be useful to have that numeric approach because you can develop some evidence to take to a doctor to say – Look, my elderly parents appear to be more sick or struggling more with breathing on days when there is high ozone. That might actually help doctors to understand and support patients more usefully around their health. Whereas other people may opt into simply receiving little images where they can click a face, a smiley face or something that tells us how hard that breathing is today. We were told that that would be a good solution. That you can give people the option.

<Displays Co-Design Following your Feedback slide>

Int: Now when they came back to us about the education, about the impact of those on health, the company actually gave us two versions of an educational module to look at. And they asked us to get feedback on which our stakeholder group preferred. So what I'd like to do today is take you slowly through this content, and give you time to look at it. There are two versions. One of them involves more pictures that look like photos. The other version uses design, so like a silhouette of a person rather than a photo of a person. I wanted to ask you and our team which are the approaches that you prefer. I will go through the different options.

<Displays sketches slide>

Int: Just to tell you what I did as part of the process, I took everybody's feedback on board, and I then went away and did a bunch of drawings trying to capture things like - Could we have a single image that shows how is ozone is formed, or methane from cows, NO2 coming from cars, radiation coming from sunshine mixing together. I gave them some images about Health Protection like maybe the recommendation could be to close the window on a day when ozone is very high. They were the sketches that I gave to the company and said – I think this is kind of what our colleagues are suggesting that we do.

<Displays Educations Module #1 slide>

Int: So the first version they gave us was using more like photos of people and objects to try and tell a story. So what I'm going to do, I'm not good to say anything, I'm just going to go through the slides as you would see them in an app. And the way that you would see them on the phone is that you would Scroll down on each consecutive image would come up. The way that you would see them on a website, you might press play, and it would animate through, or it might simply be a touch button thank you move through in this order. I will just go through it slowly.

<Displays Air Pollution can impact your health and well-being slide>

<Displays Ozone in the air can make it hard to breathe slide>

<Displays Where Ozone it come from? Slide>

<Displays Ozone is produced when sunlight mixes with emissions from factories, cars, houses and agriculture Slide>

<Displays Methane is an important emission that contributes to the formation of ozone in the air that we breathe Slide>

<Displays Methane in the air comes from oil production, indoor cookers, waste processing and cows Slide>

<Displays How can I protect my health? Slide>

< Displays There lots of things you can do to protect your health on days when ozone levels might make it hard to breathe Slide>

<Displays – Close the window, consider lighter exercise today, exercise lighter in the morning, exercise in the morning rather than the afternoon, use your preventative inhaler today, pack your blue inhaler if you're going out. Slide>

<Displays – Find out More. Slide>

Int: So something to note about this version is that there is a simple narrative throughout, and then at the very end is an opportunity to find out more. So there are links that would maybe take you to some of the slides from the first presentation, and then within that it might link you to things like websites. It could be a government website. It could be Ghana Meteorological Agency. It could be Ghana health services resources. It could be any number of things, say links to community groups. E, given that you are the only one of our colleagues in Ghana, that's seen the first slides, do you want to give us a bit of your ideas on how different this is and whether you think actually captures the feedback that our colleagues in Accra gave us?

Res1: It reflects a lot of the things that we talked about. I liked it's just on visuals, in addition to the text. I was just writing down here that maybe later during discussions, we can also mix, in terms of the visuals, mix some of the photos showing maybe local communities, women, children, especially when you talk about – How am I exposed? Especially the children who are sent to the dump sites, women with kids, maybe a farm or something. If we can typify and illustrate some of their key sources with practical situations, if we go to the waste away at the dump site. People go to the farm, they interact with cows. If you can bring up some of those, I think it will speak clearly to people. But I love that we are combining there, on the opening page was about why your health matters. It is very important. It triggers curiosity and people want to follow up and do that. I have other issues about data protection and maybe we'll talk about that during the open session. But I love it, it is looking good.

Int: It looks better than it did, doesn't it?

Res3: Yes.

Int: OK for the second version now and then we'll open up the discussion to everyone to give some feedback. And I just want to show you the second version first before we have a wider discussion just because it's a little bit different.

<Displays - Educational Module #2 slide>

<Displays - Air Pollution can impact your health and well-being slide>

<Displays - Ozone in the air can make it hard to breathe slide>

<Displays - Where Ozone it come from? slide>

<Displays - Ozone is produced when sunlight mixes with emissions from factories, cars, houses and agriculture slide>

<Displays - Methane is an important emission that contributes to the formation of ozone in the air that we breathe slide>

<Displays – Methane in the air comes from oil production, indoor cookers, waste processing and cows.

<Displays - How can I protect my health? slide>

< Displays There lots of things you can do to protect your health on days when ozone levels might make it hard to breathe slide>

<Displays – Close the window, consider lighter exercise today, exercise in the morning rather than the afternoon, use your preventative inhaler today, pack your blue inhaler if you're going out. slide>

<Displays – Find out more slide>

Int: Again, to note that for this version, there is content at the bottom of this slide, so it doesn't say anything meaningful right now, but the intention would be for there to be links to additional information for people. So rather than having it all at the end, there would be information popping up that's related to the exact content of what's on the slides. Something else I did actually check with one of our nurses in Accra, was that the blue inhaler is actually a universal thing. One of the nurses told me that yes that is actually correct. I was a little bit concerned that the blue inhaler, the one which you have when you're having an asthma attack, that that was just a UK thing. But it turns out it's actually pretty universal. The brown inhaler is your preventative, and the blue inhaler is the steroid that you take when you're actually having an asthma attack. I won't do a voting process because there aren't that many in the group, but what I did ask in the other group was just to think about the two. I would be really interested in your views on which of these options seem to be the best. It might that there are bits of one you like and bits of the other that you like, and it's not as simple as there being one better than the other. It might also be that there are problems with both of them. I'll open up the conversation then, I would love to hear what everybody thinks of this content? E?

Res5: Thank you for the presentation. I think it's very interesting. I just want to make some quick remarks. I'm thinking of if along the way there is a kind of a quiz in the form of animation that will ask app users to like maybe answer a question concerning, let's say, maybe after they are presented with causes, what brings about with ozone, and then those maintenance kind of things. So kind of a quiz, and then the app will ask the user a few questions, and then if you pass, it will take you to the next level. If you don't pass, it will send you back to the previous level to be able to get some understanding. So that will become a kind of interaction between the app and the user.

Int: I love that idea. I think that's great. I think there's a lot of these ideas that we need to store up and we start developing this further. So I think that's a fantastic idea, thank you.

Res5: Let me come in again, if we can have it in the Ghanaian context where we can have like open dumps and then women, children and those kind of people. I'm also thinking that we are speaking are speaking about, is done in the dump. So the waste because the kind of picture where we have a cow, the oil drilling and then we have the industry, that particular picture, if we're speaking about a whole kind of page on its own for waste pickers, because now we have a lot of waste pickers, especially for Sekondi here, we have more than 200 we speakers in the open dump, that is in the landfill site. And when you go to Accra, you go to the Sawa Adipal landfill, we have a whole lot of people dying to waste picking, and we also go to we go, it is an international organisation. They also do more into this waste picking. And they are at first hand in having this methane gas at the site. So if that could be captured amongst the cows, on the industries, I think it will be of help.

Int: Thanks that's really good suggestion. This may sound silly, but I wouldn't know how to depict that in an image because I've never seen waste pickers. That might be something that we need to see, or we need images of, or that we need to come and see coming you know?

Res1: There are also photos online that we can share, similar to what I was suggesting, do you want people to relate to the app, so you need to use everyday things. You know, people wake up, they go to the dump, they go to the farm. So as we look at the factory activities, oil production, and then we also come to the community level, let's debate some of these things by what people can easily relate to.

Int: Who is new in here?

Res1: It’s AM, he's with the SDMA development planning unit.

Int: M, welcome.

Res8: Thank you very much. I'm actually the metropolitan development planning officer for the Sekondi metropolitan.

Int: Thanks so much for joining us. And for introducing yourself. It's really good to have you in our meeting. Just to give you a bit of context, because I really interrupted E, I'd love to go back and hear what he was saying. I’ll just re share the content that we were looking at. <Re-shows content> I presented some content sharing some different options but how we might visualise the effect of methane and ozone on people's health. And there were two different versions of content. I asked people to give some feedback, E, I might cross back to you that's OK?

Res1: I think in the Accra meeting we discussed the degrees of exposure, right? So if you're going to superimpose people's personal data with this information that we are providing, so say someone logs into the system, they're going to provide some personal details including economic activities or the source of livelihoods. So if somebody is a waste picker or if somebody works with cows, or any of these animals that have a lot of methane emissions, can we also provide a system that the person can determine the degree of exposure or how much at risk they are? If you can build that in also that would be great. So depending on what you do, where you live, even proximity to a dump site, all of these can influence people's degree of exposure.

Int: That's a really good idea E, and it's one that have been raised by colleagues in the UK as well. People have said – What happens when somebody, if you think of the day in the life of somebody, say I work somewhere that has really good air quality, maybe I live somewhere that has worse quality, or maybe where I live is great, but actually I spend all my time at work where the air quality is terrible, so how do you actually figure out people's exposure? And it's really challenging. Maybe if somebody says that they are a waste picker, that's a bit easier, isn't it? Because they're constantly throughout the day exposed to these emissions. But if somebody works with agriculture, that is slightly different, slightly more difficult. What if somebody works in an urban area? So we've talked a little bit about solutions for this and actually one colleague who works at Plymouth, suggested developing an app that tracks where you go. So if there are known exposures in the atmosphere and in the environment that it tracks we're going gives you a daily exposure rate. I thought that's a fantastic idea. We don't have the ability to do that with this project. That would be a whole other design, a different technological solution as well, because you'd have something like a running app, you know where you record on a running app where you go, something like that. But it's also linked to exposure. I think it's a fantastic idea and I was certainly encourage my colleagues at Plymouth to do exactly that. And maybe down the track, there will be the opportunity to link in exposure.

Res1: Exactly, and looking at the bigger picture, we could consider it for a future project, when F was speaking, that's what was running through my mind, this is the beginning of something bigger, we need to plug into different projects, and some conversations.

Res3: I'm a bit more confused, confused in the science that I think I'm missing. We're missing some fundumpentals. When we look at environmental issues, we may look at them in two perspectives, two basic perspectives. That is the polluter and then the affected party. Now my concern here comes in the fact that I'm looking at - Where is the justification for the point that methane is affecting health? The correlation between one's health and then the methane level? That is my first issue. We need to justify. For example, if there is an application that will show that the methane level is high and therefore it's affecting my health, then my other option is to find out who is the polluter? Then we send our grievance to stop him, to make him work, to do something more, that there must be a mitigation effect from that polluter. And for that matter, it's an issue for concern. Secondly, if you look at the measurements, how would we measure the methane level at any point in time to determine whether if my breathing is affected, that it's coming from the methane, and not from some other gases? Thirdly, if we look on the picture on the bottom left, methane in the air comes from oil production, indoor and then we're seeing this smoke coming out. In reality, methane is colourless. It is invisible. Yet what we're seeing, we think it's sulphur dioxide, which is coming out, then we're saying it's creating confusion. I think we need to get some fundumpentals right in order to begin the process for people to assimilate. My bottom line is that this whole exercise should have some level of acceptance and desirability, people should desire. If it's accepted by both parties, the operators and then the other affected parties. If accepted by both ends, then we can reach some success. Otherwise, one of the party will be saying that there is that level of misinformation. Looking at it from the consultant perspective, grab being into environmental management from all levels, both from the government side and then the industry side, I've done a lot more on government policy regarding clean up, production, resource efficiency and all these things. So the industry operators, usually have concerns when issues like this are coming up, they want to know how would it affect them? And therefore, we need to be a little more careful with that. To have some level of objectivity, so that it's clearer. This is the issue at hand, and it can be measured. This is the correlation with health. Then if somebody is having any attack, any difficulty, that correlation is well established on the application could be more effective. That's my main concern.

Int: Thank you F, they're really valid concerns. I think that the way the images depict it right now, is not that it's the methane in the air causing sickness, but it's actually about the ozone because we know chemically that methane contributes to ozone. I know ozone has an effect on people, and there's a very big evidence base around the effect of ozone. What we're less knowledgeable about, is the actual quantifiable impact of methane on ozone. And also, there might be some direct effects of methane, say you're a waste picker and you're inhaling very large amounts regularly. We don't understand that. We don't have evidence for it. And we also are struggling a little bit to produce a data set that will show in a meaningful way the role methane plays in ozone production compared to other pollutants. So I think that you are exactly right, that there is a lot of work here that needs to be done before we can say that this is the effect methane has on health. Right now, what we can say with confidence is that methane produces ozone. Ozone has a negative effect on health. There is a lot of data to support that narrative, but it's a lot less clear if you take out the ozone, The link between methane and health directly is a lot less clear. So I think you're right, we need to be quite careful about that message. I love that you picked up on the fact that me thing is colourless, because somebody picked up on that too, and we all thought that that was a bit silly. This is just something I design companies come up with, so what we need to do is go back to them, and say - You can't show methane as brown smoke or something, because that's not what it is and it's misinformation, isn't it? Thank you, that should be useful. M?

Res8: I think he's talking about the evidence to support the fact that methane has health implications on people. I would say that in the case of Sekondi-Takoradi, we have developed what we call sustainable energy assets and climate action plan. And as part of the data, that we've got to form the baseline analysis for this plan, and then the projections into the future, we have found that our methane emissions as drastically increased in the Metropolis and it is having an impact on health and well-being of the people. So we as Sekondi-Takoradi, have data in our climate action plan. We launched the plan last week, a notice accepted as a blueprint for addressing climate change issues holistically in the Metropolis. So I think we need to refer to that plan and then we need to look at the emissions data. We have the sources, all the sources of the emissions, both stationery and mobile have been established. So we don't need to reinvent the wheel as far as the emissions are concerned. And so we have a look at this plan. If there are gaps in terms of the real evidence of impact, then we can talk about doing more studies to establish that. But as we speak, there is data to confirm that yes, methane emissions in STMA has really gone up and that the effect on human health and well-being is underscored in that report. And so, this is the words that I want to say. I can share the report after this report so we can all look at the methane emission aspect. We have actually gone around the whole of Sekondi-Takoradi to communities and disseminated the contents of this report. And the data that we used to prepare the plan was obtained through household level data collection. So this is not like only desktop. It is direct information from those who emit, those who cause the pollution. We were asking those who pollute or who am it. We have established the sources; we have established those who are encouraging it. And we have that in the plan. So this is something we can stand on to move this project forward. We can actually have data to incorporate or feed into the app if we want to use the sustainable energy assets and climate action plan (SEACAP). And so this is what I want to bring on board. The other aspect is that I know the EPA is working with, that is the Environmental Protection Agency, they're working with the SDMA to develop a similar app where we can feed in climate information into the app and the public can assess and see the effects, the levels of emissions and where there are concentrations. For example, if you come to Sekondi-Takoradi, which area of Sekondi-Takoradi is heavily polluted? In terms of concentration of the emission of methane. So these are all things that we're working on. We also need to discuss how he integrates this into that, and then make sure we don't duplicate efforts too much.

Int: M, thank you so much, I would love to see the SEACAP report. That is a really generous offer. E will help me out with emails after this. We can follow this up, and I agree, we should be working together rather than duplicating work. Let's definitely have another conversation. F?

Res3: I think I need to do a little more clarification. My concern was not the fact that methane has an implication on health. That is not denied at all. The concern is rather the correlation with the model which is relating the health of the individual at a point in time with the methane level. That is a more specific issue we're looking at, not if it has an effect on respiration. The particular matters all have an effect on respiration, even SOx because the acid also has an effect on respiration. So if we say how is your health today, There is high methane, and for that matter if you are coughing or having difficulty breathing, it is relating to methane, then we have specified it to the extent that we will have difficulty just to thank that is the methane which is causing and not something like SOx or NOx, or some other particular matter which could also be high; that's where my concern was. That's why I said the relation with help stays with methane levels, that's where my concern is. But not to deny the fact.

Int: We call that correlation, not causation. That's a really good point. I think that we would have to be very careful to not say things like methane is causing you to be ill. What we're interested in doing is helping people to understand that methane plays a role in ozone. We know that ozone is associated with health. If we know that there is one risk factor like ozone, that won't be the only risk factor, all we need to do is find a way to help people by giving them protection information but making it really clear that one factor could be ozone, rather than saying that this is definitely why you are sick. So when it comes to actually designing the information that we deliver to people like health recommendations, that's a really good opportunity to deliver that message, that this is one factor that might contribute to how you're feeling, rather than all the methane is causing you to be ill. So I think we need to keep consulting with people like yourself and others to make sure that the messages that we are delivering are accurate and clear, and that they are not giving misinformation to people. I think that's really important. I would like to share these slides with everyone, and we will find another time in the next few months to me and continue this conversation. I would definitely follow people who wish to talk individually. F, we should talk about data. M, I would love to chat to you about SEACAP. If there's anyone else who would like to talk individually, E will pass on e-mail addresses to me, so we can continue the conversation. I want to say a big thank you to everyone joining today, and a bigger thank you to E for making this possible to meet with yourselves and connecting with all of us. We will definitely continue the conversation. E and I will look for further funding to take this project forward.

Res1: Thank you so much for leading this exciting session. I think you have generated a lot of great ideas. This is just the beginning of the journey and conversation.

Int: <Discusses feedback questionnaire>

Res3: I think it's a good idea that you will follow up with us, meeting time is kind of constrained, it would be a good idea that you have that individual interaction. You can gather these points and then in our next meeting, we can discuss them with individuals. We can collate all these points and we can discuss. It would also give the individuals an opportunity to research more and then make more meaningful contributions. So I will be expecting to discuss some of these issues with you and I'll look at it too.

Int: We will set up a separate chat because I would like to talk to you about data and get some of your ideas. <Discusses Accra presentation>

Res1: I think we will call it a day. We can't thank enough at the time, festival, and also for the worth of knowledge and wisdom and experience that you shared with us. It is part of our commitment to work towards a better world. We're so glad that you responded to our call, and we are in this together. Enjoy the rest of the evening and keep in touch by e-mail.

Int: Have a great evening, see you soon.

Interview Ends