Speaker 3: [inaudible 00:02:11].

Dr. Joan Casey: What's that? Oh, you can see that?

Speaker 3: Yes.

Dr. Joan Casey: You want to see my slides? Okay.

Speaker 4: What about the top? Can we do the top [inaudible 00:02:20]?

Speaker 3: Yeah. [inaudible 00:02:22].

Dr. Joan Casey: [inaudible 00:02:23].

Speaker 3: [inaudible 00:02:26].

Speaker 4: Hide.

Dr. Joan Casey: [inaudible 00:02:28].

Speaker 3: Hide. Yeah.

Dr. Joan Casey: Hide video? No.

Speaker 4: Hide floating meeting.

Dr. Joan Casey: Okay, good.

Speaker 3: Oh, okay. Yeah.

Dr. Joan Casey: Okay, now we're in business. All right, let's talk energy in the climate crisis. So I found this, a lot of people don't realize what our energy infrastructure pre like. So I just want to walk through it. These are coal mines, and just in the Northeast. Oil and gas wells, oil and gas pipelines, petroleum refineries, natural gas processing facilities, LNG facilities, coal fire power plants, bigger circles, larger plants. Same idea here. These are oil power plants, natural gas plants, and transmission plants. So this covers our built environment and has huge implications for human health, directly and through climate change. So, talking about climate change, electric power contributes 25% of our CO2 equivalent emissions. These are the other sectors that are contributing in the United States. Fossil fuels are the primary cause here in poor agriculture [inaudible 00:03:46] fossil fuel use. Also, cows burping are a big problem, unfortunately. That's a topic for another day. And this has led to the climate crisis, right? All these emissions over time, inequitable emissions across place. And here we are. The most recent IPCC report is saying that [inaudible 00:04:09] of the climate is unequivocal. CO2 concentrations are now up to 415 per square million. So we're seeing more heat waves, more droughts, wildfires, and all of this has implications for health. Also, just to drive this home, the contributions, right? We all know this, but looking at these charts, I think is very stark. Contributions are not equitable. The United States, we can't get to the quarter finals of the World Cup, but we are leaders [inaudible 00:04:37]. Also the benefits, right? So, using energy, it has benefits for health, it has benefits for development. These are not equitable by country. Most developing countries will be considerably

less wealthy than the US when their emissions peak. For example, China will probably have about one sixth to one half of the emissions that the US have, when we will peak our carbon emissions. So, inequitable across use. I've also already seen health effects and climate related exposures that are inequitable. So this is a distribution of studies seen disparities in climate related exposures by race and ethnicity in the United States [inaudible 00:05:20] already a number of studies finding inequalities. We also know that projected impacts down the road are inequitable. This is from a recent US EPA report looking at differences in exposures and outcomes under two degrees of warming or 50 centimeters of sea level rise. I'm just showing two of the panels, they looked at several. But in general, low income and communities of color in the US are projected to have worse outcomes across most exposure and outcome domains linked to climate change. So an area I do a lot of work in, is oil and gas extraction and health. And we already see that there are inequitable health effects. So, just some examples, David Gonzalez [inaudible 00:06:10] study in California showing that pregnant individuals living closer to oil and gas wells were at increased risk of preterm birth. But this was confined to black and Hispanic birthing people. In Texas, Laura Cushing looked at natural gas related flaring and saw increased risk of preterm birth, but only among Hispanic birthing people in the state. And then we have some work out of Pennsylvania that found living closer to larger and more wells during pregnancy was related to increased risk of prenatal depression and anxiety, only among others using Medicaid as insurance. We also know that the communities experience in this extraction can be considered sacrifice zones that have been exploited over time. And we have, kind of what... I think of this fossil fuel and climate spiral. So we have fossil fuel attraction use. Some people are economically benefiting, of course, or else probably wouldn't be doing this. But it also leads to hazardous exposures, and we're releasing more greenhouse gases and we have more and more fossil fuel use, which in turn leads to rising CO2 concentrations. These climate exposures that I've been talking about, that inequitably affect certain populations and then we continually see this rise in CO2. So I'm going to talk throughout the rest of this discussion about these two areas and considerations around environmental justice and extraction use, as well as these downstream climate effects. To do that, kind of bringing together these three elements of spatial epidemiology, environmental justice, and the use of natural experiments. You'll know this, we hear our zip code is a better predictor of health than our genetic code. This is really powerful. Now, looking where I live in New York City, the upper west side, versus East Harlem, eight years difference in life expectancy. You can walk across that distance in 20 minutes. Really attributable mostly to social determinants of health and environmental exposures. We also have considerations around environmental injustice. I like this definition from Kelly-Reif and Steve Wing. Any circumstance where one population avoids hazards from a practice that negatively impacts the environment of another population. So, some people avoiding hazards and acquiring benefits through relationships that negatively impact other people. This leads to what Rachel Morello-Frosch has called this double jeopardy, where some populations have both socioeconomic

disadvantage and disproportionate environmental exposures. We've seen this a lot across a lot of the work I've done. This is just an example. We've been looking at power outages nationwide, recently. These are quartiles of county level social vulnerability. So the fourth are the most vulnerable counties and you can see a pretty distinct pattern across the year, across times of day, that the most vulnerable counties seem to have higher counts of these eight hour or longer power outages on average, at the yearly level. In addition, environmental injustice is a challenge for environmental epidemiologists. It can make it difficult to study a causal relationship because we have this circumstance where individuals who experienced more environmental hazards might have other systematic differences. I'm referring to confounding, but what I mean here, let's just walk through an example. Maybe we're interested in the relationship between hurricane exposure and asthma exacerbations, but we also know that individuals living in higher poverty neighborhoods are exposed to higher levels of hurricane exposure. How do we deal with this? Randomized trials, randomized exposure. We're not ethically going to randomize people to hurricanes. And so, what can we do? Because we can't trust that our associations are the cause [inaudible 00:10:17]. So, one thing to use are natural experiments that allow kind of this pseudo randomization of exposure in certain places and times. Examples are things like the Dutch famine, the Beijing Olympics where there was this big drop in air pollution levels in Beijing, or hurricanes, for example, that come in and change environment quickly but then things go back, somewhat to normal. So we can effectively break this link between socioeconomic status and the exposure, using natural experience. That kind of allows us to isolate this causal effect of interest. So, just to walk through an example, let's say we're in southern California. There's this power plant operating. We know that there are high rates of asthma among people living nearby, but we also know that poverty levels are quite high here. So is it poverty and building quality and associated factors that lead to asthma or is it emissions from this plant? If the plant suddenly turns off, we can compare rates of asthma pre-post within the same community, potentially using a secondary control area to isolate trends, and try to isolate the effect of the power plant on asthma exacerbations. That's what I'm going to give you an example of, now. And so, work we did on something very similar in Louisville, Kentucky where coal fire power plants turned off completely or installed emissions controls that really reduce emissions from [inaudible 00:11:49]. So we know that coal fired power plants emit a host of pollutants. In 2014, they emitted 63% of nationwide sulfur dioxide emissions, 6% of PM 2.5. These are things linked to adverse health outcomes. There are a number of studies finding associations between sulfur dioxide exposure and adverse respiratory outcomes [inaudible 00:12:17] among populations living near coal fire power plants. But in some ways, prior studies were limited. They were generally cross-sectional associational studies, usually without an objective measure of asthma symptoms. So, using something like hospitalizations to capture burden and they usually considered SO2 alone, without the host of other things coming out of [inaudible 00:12:40]. So we wanted to build on that, doing a longitudinal study looking at mixtures and measuring rescue inhaler use in Louisville.

So we did that. It was this huge partnership between folks at Berkeley and Harvard and the Louisville Department of Public Health in Kentucky and Propeller Health, which is this digital medication company that has inhalers that geotag time and location of rescue inhaler use. So we could track people over time. So, proportional symbol map, bigger circles, bigger coal fire power plants. In 2016, you can see Kentucky is located kind of in the heart of where we burn coal for electricity in the United States. It's a city of about 600,000 people. There are these four really large coal fire power plants located nearby, that either retired or installed sulfur dioxide scrubbers that reduced emissions considerably. And so we wanted to look and see whether these changes affected asthma outcomes. So, to connect the power plants to the people, we used HYADS, which stands for high split average dispersion model. Basically, it uses stack height emissions and wind direction to tell you at the daily level, where emissions from plants are going. And so, in Louisville, Kentucky, we identified the levels of HYADS in each community as a measure of how exposed they were to coal fire power plant emissions. And then we can look at how that changed over time. And this is the location of the plants included. This is levels of HYADS over time. And you can see in the second quarter of 2015 there was this huge drop in HYADS exposure on average, across Louisville. About a 55% drop. And so we wanted to look at this time period where scrubbers were installed and plants retired, whether there was a change in [inaudible 00:14:44]. So I've shown you hopefully there's this change in exposure, but what about a change in asthma outcomes? So we wanted to look both at quarterly zip code level hospitalizations and ED visits across Louisville, and then also at individual level rescue inhaler use. Here, the map, that's a lot to look at on a power plant slide, but yellow means more hospitalizations and ED visits. Dark blue means fewer. Again, marking around here, where these plants retired, you can see things are going down over time, in general. There was a median of 16 asthma hospitalizations and ED visits per zip code in the area during the study period. So, to isolate this effect, we use a difference-in-differences design, which I'm sure you're many of you are familiar with. But this design controls both for observed and unobserved time and variant confounders. It also controls for study-wide or study area-wide time varying confounders. And so what you're doing here, you're taking the difference from the pre to the post period in the exposed, relative to the unexposed group. What does that look like? So if pink on the Y axis, this is asthma visit counts, in the pre period, A1 in the exposed group, that's the number of asthma visits. A2 is in the post period. So that's our first difference, A2 minus A1, then B2 minus B1 represents the change over time in the unexposed group. And then our quantity of interest is this difference-in-differences. So we're basically using the control group to account for time varying trends that could be occurring across Louisville, like changes in how asthma visits are coded or something, in the city. So in order for this to be an unbiased causal effect, the unexposed group needs to be a good control group. And that means there can't be group-specific time trends. Things can't be changing differently in these two groups over time. So this is what it means when you hear the parallel trans assumption of difference-in-differences. So that's basically, in the absence of exposure, wood

have these parallel trends carried on through time in these two groups? You can't observe that, but you can look in the pre-period. That's what we did in our group, and compared visually, whether these trends in the unexposed and exposed group looked relatively parallel. Here, the exposed group is the highest quartile of exposure to coal in the pre-period. The unexposed are the others. So we thought it looked pretty good. We went on to run on a fully adjusted difference-in-differences model and we estimated that the energy transitions in 2015 appeared to lead to about 2.8 fever asthma visits per zip code per quarter in the post period. So, pretty sizable effect.

Speaker 3: Who is the unexposed, in that?

Dr. Joan Casey: The unexposed group are all the other zip codes in Louisville that are less exposed in the pre period. Yeah. So it's conservative, they're still exposed, they're just less exposed. So then we wanted to do this at the individual level. So like I said, we partnered with Propeller, they have this app and this digital medication sensor that geo tags the time and location of rescue inhaler use. So this was very cool and also extremely difficult data, it turns out, to work with. So we only had data on 207 people, but it's the biggest health data set I've ever worked with, because they have heartbeats every three hours over the entire study period as to where the person is located and if they've used the inhaler. And so there was a pilot going on with these 207 people during 2016, when another large plant put scrubbers on in Louisville. So we used that to look at this effect on rescue inhaler use. So, here we used a case-time series design. It's this within person analysis. Daniel is nodding, are you familiar? That allows you to control for individual level confounders because [inaudible 00:19:05] yourself over time. It's like a case crossover study, but it also has some of the benefits of a traditional time series analysis. But what we were interested in were both beta two and beta three. So, beta two being the immediate effect of these scrubbers going on. And then beta three being the time trend. Like, did inhaler use continue to go down over time after this went into place? So, in orange, we're seeing pre period average monthly use, and in maybe blue, post period. And we estimated about a 17% immediate reduction in rescue inhaler use among people in this area. And then a non statistically significant but 2% long term reduction in rescue inhaler use. So it looked like these coal fire power plant changes resulted in fewer asthma events. But we then were... I want to keep thinking about this question, and can we target regulation in ways that improve health, turning these off, as well as equitably? So this is something I've worked on. This is an example, kind of a framework that could be applied. So, here I partnered with folks at PSE Healthy Energy and we were trying to identify peaker power plants, power plants that turn on only in times of really high demand but can be really dirty when they do ramp up. We were trying to determine where you might want to replace these peaker plants in California, first, if you wanted to have the most health equity benefits. And so we combined data on electricity generation, air quality standard exceedance days and populations' socio-demographics, to try to select a framework around [inaudible 00:20:52] plants. And so what did that look like? We thought about

it in terms of how large plants were, how many people they were affecting, and then the percent of days these plants were operating where air quality exceeded standards as well as having higher Cal Enviroscreen scores. So as you move to the right and up, these might be plants that you'd want to target first, for pulling offline and replacing with something like solar and storage, if you wanted to try to improve health equity. So, something to keep thinking about as we move forward with this energy transition. So, let me now take a step backwards and talk about redlining and our energy infrastructure. So, folks, when I gave this talk or worked on these papers, probably a year or two ago, people were not as familiar, but I think now, many, many people, we've heard a lot about red lines lately. And so I'll still walk through it briefly just so we're all on the same page, but acknowledging folks are probably familiar. So, in 1933, under the New deal, the Homeowners Loan Corporation or HOLC, or apparently in social sciences, they call it HOLAC, I just found that out recently, but HOLC was created and the idea was that HOLC had a beneficial start where they were trying to make it so people could stay in their homes or help with the housing shortage, so people could afford to buy homes in the suburbs. They offered low interest rate loans. This was all good, but it was nationwide. And so in order to determine where to give out mortgage loans that people would be able to pay back, HOLC created what were known as the security maps. It allowed them to efficiently assess the risk of offering loans in different areas. Unfortunately, this turned out to be a very discriminatory mortgage lending practice. Each neighborhood in the US that had one of these maps drawn, had communities that were either labeled as green, best, blue, still desirable, so still getting loans, and then yellow, definitely declining, and red, hazardous, which of course gave way to the term, redlining. Decisions about which color to shade neighborhoods was based primarily on the vicinity of industry, prior housing sales, and importantly, racial and ethnic composition of these communities. I'll show you a documentation that was filled out by a neighborhood, in a second. But to zoom in, let's look at a redline neighborhood in Baltimore. So this was neighborhood D5 in the city, and here was actually part of the form. Each neighborhood in each city had these forms filled out. And so, telling us that it's a security grade D, what the train is like, were there favorable influences? So here it was near employment, it was central, but then it also had detrimental influences including industrial encroachment. And then there were actually lines where it was designated, what were the percent of foreign-born individuals living in this neighborhood? They have an infiltration line and they also have a line specifically about the Negro population in each of these communities. And so, many people have shown extremely strong correlations between racial ethnic makeup in the 1930s and how these neighborhoods were created. And does that still matter today? This happened in the 1930s. I would argue that it really does. So we know that people of color have experienced much lower home ownership rates in the United States, for decades. It was very wide and it has not closed at all, over time, comparing non-Hispanic white Americans to other groups. We also have massive wealth gaps by race ethnicity in the United States, that we know are also very predictive of health. So you can see in 2013, the average white family had 13 times greater

wealth than the average black family in the US, had 10 times greater wealth than the average Hispanic family. Redlining also solidified racial segregation in the United States. So this is Baltimore. This is a density map of modern day on the right, where yellow is non-Hispanic or Latino population and black or African American alone. And then the tan is non-Hispanic white alone. So you can see Baltimore's an extremely segregated city, but there's some alignment with these historic maps. And why do we think segregation matters? There are a number of reasons. One big one from an environmental perspective is that it separates groups from opportunity, amenities, and resources, to the detriment social, political and economic standing, and environmental health. So, we've also seen in a number of studies that historic redlining is tied to worse present day health. So this is a study I collaborated on with folks in California where we looked at historic HOLC grading in the state of California and modern day asthma ED visit rates. The maps for the study are just incredibly compelling. We basically didn't need to do any analysis. You can visually look at almost these exact boundaries showing up on these maps. Redlining is, of course, part of our greater societal system, and downstream from structural racism. This is a really nice article by Swope, Cushing and Diana Hernandez, kind of highlighting pathways through which redlining can be linked to health, but it kind of puts this within the broader context. And then stepping back even further, redlining is, of course, just one of many, many mechanisms that have led to environmental injustice. So this is Dorceta Taylor's great book, Toxic Communities. I will not go through all these, but basically to tell you there are many mechanisms through which this is happening. Redlining has been studied a lot lately, because I think it's easily measured. We have these really nice maps, but there are many, many other mechanisms that are in play. So what did we want to do in this work on historic redlining and fossil fuel exposure? So, one, we are interested in whether redlining was related to energy infrastructure in the 1930s. So I told you that industrial development was tied to the grades these communities received. So we were interested in that association in the 1930s. And we also wanted to know, what about today? Is there still this link between grades received in the 1930s, and power plant and oil and gas exposure, modern day? So this is work in partnership with a lot of collaborators. But one study led by David Gonzalez who's a postdoc at Berkeley, and Lara Cushing, who's faculty at UCLA. In both of these studies, we used the redlining maps from the Mapping Inequality Project, where they basically digitized these old maps. You can go on and download [inaudible 00:28:17] for every city in the US. We also had information on energy infrastructure. So, oil and gas wells, dating back to pre-1900 from Enverus, which is an industry website, but actually they give free use to academics, which is strange and great. And so we included all oil and gas wells in the US that were located within a kilometer of one of these HOLC graded communities. And then we used EIA information on fossil fuel generating plants, and we included those that were within five kilometers of HOLC graded communities. So we had information in the 1940s at the census tract level to provide socio-demographics on these communities. And then we wanted to use propensities for restriction and matching, because there's this

issue where we wanted to control for neighborhood characteristics that might have confounded this relationship. Because we were trying to isolate the effect of actually getting a HOLC grade on proximity to industry or on future proximity to wells and fossil fuel plants. But there is this issue that many, that I'll show you in a second, that communities that received a grade D, were very unlikely to, example, receive a grade A. And so we see a lot of comparisons between grade A and grade D communities. But I'm not sure those... These aren't exchangeable groups. From an analytic perspective, I'm not exactly sure what it means. We could talk more about that. I think it's an interesting problem. But I'll talk to you about what we did to deal with that. And then for power plants, we actually used wind direction to try to look at communities located downwind of fossil fuel plants, as a bit of an instrument. So this is what I'm talking about. This is the propensity of communities to be graded C or D in the United States. And so the propensity score is along the X-axis. So, one would be a 100% propensity to get a grade C or D. A zero would be no propensity. You can see those that actually received grade A, generally had almost no propensity to get a grade C or D. And those that received a grade D were very likely to have received that grade, based on the characteristics that we know about that community. And so it doesn't make a ton of sense to me to compare grade A and grade D. So what we did- Yes?

Speaker 3: Sorry.

Dr. Joan Casey: No, please.

Speaker 5: What factors did you use to predict the propensities here?

Dr. Joan Casey: Yeah, so we used all those census variables from the 1940 census. So, interesting things that get it, socioeconomic status, like, does the family own a radio? Do they have heating? Is there indoor plumbing? Things that we thought would be correlated with SES and also racial [inaudible 00:31:08].

Speaker 5: Thank you.

Dr. Joan Casey: And so, in our analysis, we're just going to compare adjacent grades to each other and we're also going to use propensity score matching to try to get closer to a causal effect, which is what we were interested in. But actually there are a lot of other interesting questions about mechanisms and other things that you might not want to use the same methods. So, anyway [inaudible 00:31:32]. So here are the studies included in the oil and gas well study across the US. So they had to be cities that both had... So these are urban oil and gas wells, because these HOLC neighborhoods were located in cities. And then they also had to have census data to do these analytic methods. So to give you a sense of what this looks like, the Xs represent oil and gas wells. This is a neighborhood in Los Angeles. And so you can just see kind of how we did this. We counted up the number of wells located within each boundary and then within one kilometer around. And so this is before appraisal. So this is looking at exposure to fossil fuel facilities in the 1930s. And you can see, even before these boundaries were drawn, places that in the future, received a

grade D, had more exposure to oil and gas wells, as we might have expected. We see a similar trend with location near power plants, fossil fuel power plants. So, grade D communities, about 2% of them were located downwind of a fossil fuel plant. So then, let's flash forward to present day. So, on the left, we're looking at wells. This is over time. So this relationship held up and there are many more wells than pre HOLC boundary drawing. Then in the second panel, we're comparing grades to one another. So for example, if we look at [inaudible 00:33:12] the box here, if we look at this one, grade D to grade C, we can say that grade D neighborhoods on average have two more wells within them than grade neighborhoods. And this kind of gradient goes up across comparisons. Then on the right hand side, we're looking at the percent of these communities that were downwind of a fossil fuel power plant. We see this gradient across time, and this is when the power plant was actually opened. So it's pretty persistent over time. So it suggests this persistent structural environmental racism in the United States that's affecting air quality and water quality and other things. And then, what about present day power plant emissions? So we also wanted to look at this in the power plant paper, and we do see, in fact, that SO2 emissions, for example, are higher in grade D communities that are exposed to power plants. And we see this also comparing adjacent grades, that grade D versus grade C, for example, emissions are higher. So, despite being outlawed, it does seem like there are effects of these historic redlining maps drawn in the 1930s and that appear to persist today. So let me finish up. Good. I'm doing okay on time, so we'll have time to chat. So I want to talk a little bit about some of my ongoing work, what I'm doing now I'm excited about. So here we are looking at the overlap of oil and gas wells with wildfires that are primarily climate-driven, and we are curious as to whether there's much overlap between these two phenomena in the United States. We started thinking about this because we saw these maps, sorry for such a crazy slide [inaudible 00:35:14]. On the far left, we're looking at where wildfires were located between 1980 and 2020. Red are fires that burned in the 2010s, orange, 2000s, et cetera. We know that burned area in the United States is going up over time. And then in the top right, I'm showing you the location of oil and gass wells in the US. So, just kind of looking at these maps, two different things that I studied. We started wondering, this is work with David Gonzalez, again, who's a postdoc at Berkeley, are these things overlapping? Are they interacting? What might be going on? And I guess we're interested in, the risks of having them overlap isn't totally clear. There's, of course, acute safety concerns and short-term air pollution exposures for people that work on these facilities or that live nearby. There's also potential for long term impacts for water quality. And then of course, methane is what's coming out of natural gas wells. So, more release of greenhouse gases that can feed back into climate change. So here's an example of some of the findings. So this is a fire that burned in Oklahoma in 2009. The red is the boundary of the fire. The black Xs are oil and gas wells. The yellow is a one kilometer boundary around the fires. And so this is a fire that burned over 4,000 wells in Oklahoma in 2009 and is representative of what we're seeing across the US. So this actually seems to be pretty pervasive.

And I want to talk for a moment about... Because in addition to looking at what's burned so far, we wanted to look at risk for the future. So, here, we're looking at the Keetch-Byram Drought Index, or KBDI. This is basically based on cumulative moisture deficiency of [inaudible 00:37:05] soil layers. So, a KDBI of 450 or greater is considered important, because if a wildfire starts burning in an area with that level, it's likely to become really secure and spread and has potential [inaudible 00:37:20]. So this is the distribution of KBDI in the United States in 2017, and in 2017, there are over 600,000 wells in the US, located in high wildfire risk zones. Many of them are in Texas. Almost every well in California, actually is already in a high wildfire risk zone, and you can see this across some other states, as well. Then, considering mid-century. So this is projected wildfire risk in 2050. And so, just looking at wells that are already drilled now. Not considering the placement of new infrastructure, by 2050, there would already be nearly a million oil and gas wells in the US that are located in these high wildfire risk zones. So in 2050, every single well in the state of California is now in a high wildfire risk zone. In Texas, over 400,000 wells are located in these zones. So this continues to be a problem, hasn't really been looked at, and from a health perspective, really interested in continuing to explore what's going on here. Okay. So, more good news. IPCC now says there's this rapidly narrowing window to enable climate resilient development. How did this happen to us? EO Wilson says we have this myopic fog because it was actually advantageous to place a premium and close attention into the near future and early reproduction from an evolutionary perspective, and little else. Our minds only work well, backward and forward, for a few years. People who had genes that inclined them to short term thinking, did better. Profits never enjoyed a Darwinian edge. So that's hard. But there are people, there are indigenous populations in the United States, for example, that use things like seventh generation thinking, thinking about, okay, decisions we make today, how is that going to affect people seven generations down the line? So, kind of this spectrum, from where we are, to seventh generation thinking, which is maybe closer to where we need to be. I think the recent Inflation Recovery Act, moved us a little bit up this line. So it's been an okay year for climate change. So the IRA, and these are estimates out of Jesse Jenkins's lab at Princeton, but the IRA is closing two thirds of the remaining gap between current policy and our 2030 goal of being 50% below 2005 emissions. So it's getting us quite a long way there. It's working mostly by taxing corporations. It's going to expand clean energy by making tax credits more accessible, and actually extending them for 10 years, so we can rely on actually having access to clean energy credits. There's $60 billion going into manufacturing of solar and batteries and other clean energy technologies in the US. And then there's also an estimated $40 billion to $60 billion of environmental justice spending in this bill, kind of in line with Biden's Justice 40 initiative. So this includes things like $9 billion in home energy rebate programs that can go to low income communities. Very happy to talk more about the reasons some EJ groups are not happy about this bill. But I think for me, on the whole, I'm happy that this has passed. Absolutely. There are certainly issues. So my hope is that IRA passing, and

hopefully we're starting to do some things here, can take us from an energy infrastructure that looks like this, to where we are with solar and wind, now, and build this out. It's not going to be easy. It needs to be accompanied by a just transition, where we're providing support for those communities that historically relied on fossil fuel extraction. But I think it is still possible, and there's also not just thinking, but science backing up, it's still possible to bring warming back to 1.5 C in the second half of the 21st century. Lest we [inaudible 00:41:51], we have Bill McKibben up here, reminding us, "The danger is that you have a world that runs on sun and wind but is still an essentially broken planet." So, yes, there will be suffering in the coming years, but that's why we need all hands on deck to consider policy, equity, and climate change in the coming decades. And hopefully as we evaluate policy and these other massive shifts, our results can help us reimagine the world we want to live. A world that centers on equity and maybe gets closer to this [inaudible 00:42:24]. So I'll finish by saying we have the tools to do this, we just need to take it one step at a time. So I will stop there. Thank you to numerous collaborators that I couldn't have done this without, and funding from NIA and NIHS. Thank you all very much.

Speaker 1: I will open for questions, so if you do have any questions, please. Yeah, [inaudible 00:42:54].

Speaker 6: Thank you for your presentation. It was very [inaudible 00:42:59]. So I think it was very interesting because it almost seems like redlining is such a long time ago type of policy or some racist things that's really long time ago. And then the impact is still shockingly high, especially you see the siting and everything actually all mixed together, that has disproportionately located in some of the marginalized neighborhoods. So that was very interesting to see. And then I guess you talked a lot about the correlation and association between all these things, bad things, and then together. So are there any actual recommendations that you think the government or the community can take at this moment? Because damage is done, it's hard to just reverse back to what it was. So what are some of the future things that you suggest?

Dr. Joan Casey: Yeah, okay. So should I repeat for people online, or I'll summarize? Okay. The question is, A, redlining was a really long time ago. Interesting to see correlations with what's going on today, and what can communities and others do to try to rectify the situation we've gotten ourselves into? So, yeah, acknowledging this was a long time and I think there's actually still a lot of work looking at the pathways for which we've gotten here. So, redlining is just one federal policy that occurred. There are many, many, many others. And so, figuring out which are most impactful. So I think there's a need for some mediation analysis, for example. So, redlining led to all these downstream effects that then led down farther that then eventually led to adverse health effects in the 2000s. And so we don't understand all those linking pathways yet and it's going to require interdisciplinary collaborations and social scientists and data scientists and people across the spectrum, to figure that stuff out. In

terms of recommendations, some of the best things that have happened lately I think are things like Biden's Justice 40 initiative where 40% of spending on climate infrastructure is supposed to go to historically marginalized communities that are identified. So this, is for example, done in California now, using Cal Envirsoscreen, which is this index that's created across the state that looks at cumulative social and environmental exposures. And then actually, money from California's Cap-and-Trade bill is allocated to the highest quartile communities on that score to help pay for improvements in infrastructure, quality of the environment, building upgrades, other things that those communities might need. So I do think a lot of what we've done has happened really inequitably. And so we need to make equity part of all these policy changes that are going to go into place with climate change going forward, because there's going to be huge silo change in the next 30 years. And so we have a lot of opportunities to make better decisions, this time around. So we just need to keep getting equity into the equation.

Speaker 7: I'm curious about the work that you're doing recently with wildfire risks and well density, I guess. Have you considered looking at the impacts of drought and how that relates to wildfires?

Dr. Joan Casey: So the question is, have we looked at droughts and wildfires? We have not, but I think it's a really interesting question from a lot of different angles, actually, because obviously drought is one of the main reasons California has been burning so much, especially this phenomena where it rains a lot early in the year and all these little plants sprout and then it's super, super dry and then everything burns. So that's clearly kind of one of the... It's on this pathway from climate change, direct to wildfire. But there's also, when we're thinking about health endpoints, I think a direct effect from drought on health, also, that would be really important. And some people are looking at that like Jesse Berman is at Minnesota, because from air pollution, also in California Central Valley, infectious disease or fungal exposures are important because things can kick up into the air more when it's dry and dusty. So I do think drought is really critical but we haven't looked at it in relation to wildfire or health, yet. But it is something we continue to talk about. Yeah. Yeah?

Speaker 8: Yeah. So I had more of a macro question, which is, in your work, one of the things that we're trying to do at our center is to have our work have more policy impact, and I'm wondering if that's something that you also have been thinking about, and if you have any success stories around that.

Dr. Joan Casey: Yeah, thanks for setting me up. That's so nice. So the question was, policy, do I have any stories about successes? Yeah, a couple. So, not related to the things I talked about today, but my dissertation was on residents near large scale factory farms and risk of antibiotic resident infection in people living nearby. And so we did find that... And that's because of this sub... Maybe people aren't familiar, let me step back. There's a lot of subtherapeutic antibiotic use on livestock farms. About 70% of antibiotics sold in the US are used in livestock, not in human medicine. And so this subtherapeutic use can

result in the selection or bacteria that's resistant to antibiotics that can then colonize and infect humans. And so we did find people living nearby were more likely to have antibiotic resistant staph infections. And so that work actually, when I got to California as a postdoc, California was considering a bill to ban this type of antibiotic use in the state, and I was actually able to go meet with legislators, with the governor's aide, and actually talk about my studies in collaboration with NRDC, who helped write the bills. And that was a really great experience and this bill actually ended up passing and I now have a grant with [inaudible 00:49:53] California where we're evaluating it to see if it actually did result in changes in bacteria on retail meat or not human infection. It did take a lot of work, though, I will say. It would've been very easy to publish my studies and then go to a postdoc. But I spent a lot of time learning about how to talk to people, answering reporters' calls. Actually, this work got covered on Frontline, which is, I think, why I was asked to do this. But it's a lot of extra stuff. But if it's important to you, I think it's a really valuable skill to develop, and it's good to start doing it sooner, just as much as you can. And then actually, Nicole, Diesel and I have been involved in California. They've been working on oil and gas, new oil and gas regulations, basically, in the state. And so we've been sitting on this public health panel that's advising the governing body, CalGEM, that regulates oil and gas. And so, along with many others, have been reviewing literature and kind of providing a full report on what they could do to protect health better in the state. And so that's actually also been incredibly interesting. And one of the takeaways there for me was, really important to talk to policy-makers early when designing studies, to make sure that the effects you're estimating, are of use for them to develop policies on. So, for example, I've done a lot of work on fracking and we've created a lot of exposures that are pretty complicated, that we try to develop to better estimate true exposure to fracking wells. But these complicated models don't easily translate into a policy decision. It would've been probably more helpful if we had used just a distance from a well as the exposure, because then at least it informs, what's a safe setback distance from a well, that would be public health protective? So while we probably did... We have less exposure misclassification in our studies. It's not as easily translatable or comparable to studies conducted in other places. And so, thinking through these kinds of decisions in the process of designing the study, there are, I'm sure, corollaries to this in many other fields, can be really helpful when trying to get your work translated into policy. Yeah. I think there's a question in the chat. Oh, great. Yeah, I'll just read it out loud. "It was very interesting and scary..." Agreed, "to see the co-location of wildfires and oil wells. There have been several massive and long lasting releases of methane in the US over the past few years." Yep. Aliso Canyon, near LA. "Can you compare that impact, with the impact of burning of oil wells as far as climate impacts go?" I think that that's a great question and a direction that we might want to go. It also could be really interesting to try to use satellite imagery once we identify some of these main... Because we've identified 50 or more wildfires that have burned thousands of wells. So it would be interesting to go back in time and try to catalog this. And also thinking about the technologies

folks used at Aliso Canyon. I know there's been continual air monitoring going on, there. So yeah, for now we're starting with even talking about this problem that we didn't realize existed. But I think there are many studies that could come after this, that would be important in terms of understanding climate health impacts. Yeah. So, thank you.

Speaker 1: Thank you everyone. So I think, in the interest of time, we have to end this seminar. Thank you, again [inaudible 00:53:48].