WEBVTT

1 00:00:02.190 --> 00:00:03.270 line:15% <v Dr. Rao>Good afternoon, everyone.</v>

2 00:00:03.270 --> 00:00:05.400 line:15% Thank you so much for being here.

3 00:00:05.400 --> 00:00:06.560 line:15% First of all, before I start,

4 00:00:06.560 --> 00:00:07.780 line:15% I wanted to apologize,

5 00:00:07.780 --> 00:00:11.510 line:15% especially for those who are physically present at the venue

6 00:00:11.510 --> 00:00:13.520 line:15% that I can't be there in person.

7 00:00:13.520 --> 00:00:16.950 line:15% I very recently received an invitation to attend a meeting

8 00:00:17.830 --> 00:00:21.400 line:15% that was closed on invitation for a discussion

9 00:00:21.400 --> 00:00:23.030 line:15% about energy transitions in the U.S.

10 00:00:23.030 --> 00:00:25.740 line:15% that I considered important to attend.

11 00:00:25.740 --> 00:00:28.130 line:15% And, I couldn't find any flights that would bring me

12 00:00:28.130 --> 00:00:29.140 line:15% to the meeting on time.

13 00:00:29.140 --> 00:00:31.020 line:15% Other than one,

14 00:00:31.020 --> 00:00:33.620 line:15% for which I am on my way to Newark Airport,

15 00:00:33.620 --> 00:00:34.580 line:15% literally right now,

16 00:00:34.580 --> 00:00:36.570 line:15% as you listen to this.

17 00:00:36.570 --> 00:00:37.403 line:15% But I will,

18 00:00:37.403 --> 00:00:41.930 line:15% however, join in about 40 minutes to answer your questions.

19 00:00:41.930 --> 00:00:44.240 line:15% So, if you could please just make note of your questions

20 00:00:44.240 --> 00:00:45.370 line:15% as we go along.

21 00:00:45.370 --> 00:00:49.513 line:15% I'd be happy to discuss them live at the end of this talk.

22 00:00:50.380 --> 00:00:51.560 line:15% So, I'm gonna talk today,

23 00:00:51.560 --> 00:00:53.950 line:15% about a study that I did while I was working

24 00:00:53.950 --> 00:00:56.490 line:15% at The International Institute for Applied Systems Analysis,

25 00:00:56.490 --> 00:00:59.230 line:15% IIASA, a few years ago.

26 00:00:59.230 --> 00:01:01.480 line:15% That took a couple of years to complete

27 00:01:01.480 --> 00:01:04.000 line:15% and finally resulted in the publication,

28 00:01:04.000 --> 00:01:06.050 line:15% just a few months ago in nature sustainability,

29 00:01:06.050 --> 00:01:08.270 line:15% which makes me very happy.

30 00:01:08.270 --> 00:01:12.010 line:15% And the two main reasons I'm interested to do this talk.

31 00:01:12.010 --> 00:01:13.640 line:15% The first is,

32 00:01:13.640 --> 00:01:15.950 line:15% the empirical insights.

33 00:01:15.950 --> 00:01:16.783 line:15% This is the,

34 00:01:16.783 --> 00:01:18.240 line:15% only the second study I know of.

35 00:01:18.240 --> 00:01:19.810 line:15% And the first in India

36 00:01:19.810 --> 00:01:23.570 line:15% that relates the consumption side or the contribution side

37 00:01:23.570 --> 00:01:26.760 line:15% of air pollution in India to the impact side.

38 00:01:26.760 --> 00:01:27.893 line:15% And specifically,

39 00:01:28.800 --> 00:01:31.890 line:15% which households, of what categories of income

40 00:01:31.890 --> 00:01:34.540 line:15% contribute to different sources of pollution?

41 00:01:34.540 --> 00:01:37.610 line:15% And, to what extent are they impacted by that pollution

42 00:01:37.610 --> 00:01:40.530 line:15% in terms of the risk of mortality?

43 00:01:40.530 --> 00:01:42.420 line:15% And in doing that,

44 00:01:42.420 --> 00:01:45.600 line:15% I think it's important from a policy perspective,

45 00:01:45.600 --> 00:01:46.840 line:15% asking this question,

46 00:01:46.840 --> 00:01:49.640 line:15% because it allows us to think about consumption

47 00:01:49.640 --> 00:01:52.850 line:15% as one of the options for mitigation of air pollution,

48 00:01:52.850 --> 00:01:55.800 line:15% and not just looking at end of pipe controls.

49 00:01:55.800 --> 00:01:58.770 line:15% And this is one avenue for us to think about

50 00:01:58.770 --> 00:02:02.010 line:15% how sustainable consumption can be brought into the fore

51 00:02:02.010 --> 00:02:03.830 line:15% in terms of the solutions to address,

52 00:02:03.830 --> 00:02:04.700 line:15% not just climate change,

53 00:02:04.700 --> 00:02:06.530 line:15% but air pollution as well.

54 00:02:06.530 --> 00:02:07.660 line:15% The second reason,

55 00:02:07.660 --> 00:02:08.493 line:15% is that to me,

56 00:02:08.493 --> 00:02:10.050 line:15% this is a very interesting exercise

57 00:02:10.050 --> 00:02:12.210 line:15% in interdisciplinary research.

58 00:02:12.210 --> 00:02:15.310 line:15% And specifically in integrated assessment.

59 00:02:15.310 --> 00:02:17.470 line:15% So, there was an air pollution group in IIASA.

60 00:02:17.470 --> 00:02:19.500 line:15% There is an air pollution group.

61 00:02:19.500 --> 00:02:21.760 line:15% Which many of you I know are familiar with,

62 00:02:21.760 --> 00:02:24.290 line:15% that run the GAINS Model that I will talk about.

63 00:02:24.290 --> 00:02:25.380 line:15% And there's the energy group

64 00:02:25.380 --> 00:02:27.000 line:15% that runs an integrated assessment model.

65 00:02:27.000 --> 00:02:30.840 line:15% And does other research on energy system transformations

66 00:02:30.840 --> 00:02:32.670 line:15% for climate change.

67 00:02:32.670 --> 00:02:34.980 line:15% And what I was looking with this group,

68 00:02:34.980 --> 00:02:36.860 line:15% I saw that there was these two different groups

69 00:02:36.860 --> 00:02:41.860 line:15% that had a completely different work research agendas.

70 00:02:42.910 --> 00:02:43.890 line:15% But they had of course,

71 00:02:43.890 --> 00:02:45.990 line:15% collaborated to look at co-benefits

72 00:02:45.990 --> 00:02:48.040 line:15% between air pollution and climate change.

73 00:02:48.910 --> 00:02:51.230 line:15% But never specifically thinking about the relationship

74 00:02:51.230 --> 00:02:54.680 line:15% between the contributions from the energy sector

75 00:02:54.680 --> 00:02:55.610 line:15% to air pollution.

76 00:02:55.610 --> 00:02:58.520 line:15% And who causes that from the household perspective.

77 00:02:58.520 --> 00:03:00.130 line:15% And so, I saw these two different groups

78 00:03:00.130 --> 00:03:03.531 line:15% and the opportunity to build some bridges between them.

79 00:03:03.531 --> 00:03:06.270 line:15% And pull that off after a few years.

80 00:03:06.270 --> 00:03:07.610 line:15% So, I think methodologically,

81 00:03:07.610 --> 00:03:09.080 line:15% it's an interesting example

82 00:03:09.080 --> 00:03:11.090 line:15% of applied interdisciplinary research

83 00:03:11.090 --> 00:03:13.060 line:15% that I think would be nice to replicate

84 00:03:13.060 --> 00:03:15.230 line:15% in other contexts as well.

85 00:03:15.230 --> 00:03:17.310 line:15% So, I wanna provide some background

86 00:03:17.310 --> 00:03:19.290 line:15% to air pollution in India.

87 00:03:19.290 --> 00:03:24.290 line:15% I'm gonna discuss mostly the methodology that we applied

88 00:03:24.500 --> 00:03:25.333 line:15% in doing this,

89 00:03:25.333 --> 00:03:27.920 line:15% which I think is the most interesting part to this audience.

90 00:03:27.920 --> 00:03:29.810 line:15% And then discuss some of the results

91 00:03:29.810 --> 00:03:31.763 line:15% and the implications for policy.

92 00:03:36.230 --> 00:03:38.530 I think it's pretty clear to everyone in this audience

93 00:03:38.530 --> 00:03:40.213 that particulate matter,

94 00:03:40.213 --> 00:03:44.200 fine particulate matter has serious health effects

95 00:03:44.200 --> 00:03:47.870 and leads to the death of over a million people a year

96 00:03:47.870 --> 00:03:49.270 in South Asia alone.

97 00:03:49.270 --> 00:03:51.550 And that affects mainly women and children.

98 00:03:51.550 --> 00:03:53.850 And this is through various diseases

99 00:03:53.850 --> 00:03:54.810 that you're familiar with;

100 00:03:54.810 --> 00:03:57.563 pulmonary diseases, cardiovascular diseases,

101 00:03:59.270 --> 00:04:01.800 lower respiratory infections that children face,

102 00:04:01.800 --> 00:04:03.050 and many others.

103 00:04:03.050 --> 00:04:04.850 The main point I wanted to make about this,

104 00:04:04.850 --> 00:04:08.780 is as you're all familiar with the dose response functions

105 00:04:08.780 --> 00:04:10.480 in terms of the relative risk

106 00:04:10.480 --> 00:04:12.730 and the relationship to concentrations,

107 00:04:12.730 --> 00:04:15.220 to ambient concentrations is nonlinear.

108 00:04:15.220 --> 00:04:16.320 And what this means,

109 00:04:16.320 --> 00:04:19.050 is that you have to make very, very significant reductions

110 00:04:19.050 --> 00:04:21.040 in the concentration levels,

111 00:04:21.040 --> 00:04:24.960 in order to really see significant impacts on health.

112 00:04:24.960 --> 00:04:27.370 And I bring this up because in India,

113 00:04:27.370 --> 00:04:28.203 in particular,

114 00:04:28.203 --> 00:04:30.790 there has been a focus on residential use of cookstoves

115 00:04:30.790 --> 00:04:33.010 as the primary source of air pollution.

116 00:04:33.010 --> 00:04:34.480 And it is specifically,

117 00:04:34.480 --> 00:04:36.260 for indoor air pollution.

118 00:04:36.260 --> 00:04:41.190 And there've been numerous studies and programs over decades

119 00:04:41.190 --> 00:04:42.060 in South Asia,

120 00:04:42.060 --> 00:04:45.740 to try to create improved cookstoves that burn biomass

121 00:04:45.740 --> 00:04:47.040 in a better way,

122 00:04:47.040 --> 00:04:48.560 and have failed for decades.

123 00:04:48.560 --> 00:04:49.780 And that's because,

124 00:04:49.780 --> 00:04:51.950 although they've had some kinds of improvements

125 00:04:51.950 --> 00:04:53.130 in reductions in pollution

126 00:04:53.130 --> 00:04:56.110 and improvements in efficiency of the stoves.

127 00:04:56.110 --> 00:04:58.480 They don't lead to strong enough reductions

128 00:04:58.480 --> 00:05:01.430 in the concentrations in indoor air pollution.

129 00:05:01.430 --> 00:05:04.540 So, it's important to know that there are several other

130 00:05:04.540 --> 00:05:07.620 aspects of air pollution that are from other sources,

131 00:05:07.620 --> 00:05:09.273 that affect people's health.

132 00:05:10.640 --> 00:05:14.070 Those who are burning solid fuels for cookstoves

133 00:05:14.070 --> 00:05:15.820 by ambient air pollution that they inhale

134 00:05:15.820 --> 00:05:17.100 when they leave the house as well.

135 00:05:17.100 --> 00:05:18.450 And that's what this paper is about.

136 00:05:18.450 --> 00:05:21.000 It's about ambient air pollution for the most part.

137 00:05:21.916 --> 00:05:24.010 There's several different sources in the economy

138 00:05:24.010 --> 00:05:25.270 for air pollution,

139 00:05:25.270 --> 00:05:27.050 besides cookstoves.

140 00:05:27.050 --> 00:05:28.790 Households that don't have electricity access

141 00:05:28.790 --> 00:05:30.410 use kerosene for lighting.

142 00:05:30.410 --> 00:05:32.040 And that is an important source.

143 00:05:32.040 --> 00:05:34.320 A lot of people don't know that in urban areas of India,

144 00:05:34.320 --> 00:05:36.470 where they don't have access to biomass,

145 00:05:36.470 --> 00:05:38.380 that they use kerosene for cooking as well.

146 00:05:38.380 --> 00:05:40.203 So, this is also an urban problem.

147 00:05:41.240 --> 00:05:42.900 Traffic and air pollution of course,

148 00:05:42.900 --> 00:05:43.740 is very well known.

149 00:05:43.740 --> 00:05:47.220 And I think there's a stereotype that in cities in India,

150 00:05:47.220 --> 00:05:50.910 the traffic burning diesel from buses

151 00:05:50.910 --> 00:05:53.770 and single stroke engines are really the main cause

152 00:05:53.770 --> 00:05:54.810 of air pollution.

153 00:05:54.810 --> 00:05:55.643 But as I show you,

154 00:05:55.643 --> 00:05:57.680 it's much more complicated than that.

155 00:05:57.680 --> 00:05:58.940 A lot of industry,

156 00:05:58.940 --> 00:06:00.810 as I show the brick kilns over here,

157 00:06:00.810 --> 00:06:05.520 is one primary suspect are also major contributors.

158 00:06:05.520 --> 00:06:07.223 Of course, power plants as well.

159 00:06:08.090 --> 00:06:11.570 And, very often there are times in the year

160 00:06:11.570 --> 00:06:13.120 when the pollution is particularly bad,

161 00:06:13.120 --> 00:06:14.420 as you can see in these photographs,

162 00:06:14.420 --> 00:06:15.390 in New Delhi.

163 00:06:15.390 --> 00:06:18.330 Because you have burning of agricultural fields

164 00:06:18.330 --> 00:06:21.640 to clear the fields for the next seeding.

165 00:06:21.640 --> 00:06:23.610 That takes place next to winter.

166 00:06:23.610 --> 00:06:25.560 And so they cause very, very high concentrations

167 00:06:25.560 --> 00:06:26.940 of pollution.

168 00:06:26.940 --> 00:06:28.207 And those also,

169 00:06:28.207 --> 00:06:30.500 are a little bit misleading because they are concentrated

170 00:06:30.500 --> 00:06:31.810 in a week or two.

171 00:06:31.810 --> 00:06:32.643 And, you know what?

172 00:06:32.643 --> 00:06:34.060 If you look at average air pollution over the year,

173 00:06:34.060 --> 00:06:37.040 they tend to be many other sources that dominate

174 00:06:37.040 --> 00:06:38.790 the agricultural emissions as well.

175 00:06:42.130 --> 00:06:43.780 So, it's known that globally,

176 00:06:43.780 --> 00:06:47.830 all of these sources contribute to air pollution at PM2.5.

177 00:06:47.830 --> 00:06:49.530 But, in different parts of the world,

178 00:06:49.530 --> 00:06:51.630 different sources dominate.

179 00:06:51.630 --> 00:06:52.920 So in the U.S. for example,

180 00:06:52.920 --> 00:06:55.613 power plants and traffic dominate.

181 00:06:56.560 --> 00:06:58.280 But in Northern Africa,

182 00:06:58.280 --> 00:07:03.020 of course, the dust from the desert as a major contributor.

183 00:07:03.020 --> 00:07:05.930 I didn't mention in the previous slide that natural sources

184 00:07:05.930 --> 00:07:08.400 are a very significant contributor as well.

185 00:07:08.400 --> 00:07:10.210 Including dust that's often picked up

186 00:07:10.210 --> 00:07:12.540 from construction work as well.

187 00:07:12.540 --> 00:07:15.540 We'll see how that plays a role in India as well.

188 00:07:15.540 --> 00:07:18.890 And as you can see on the chart here in South Asia,

189 00:07:18.890 --> 00:07:21.630 cookstoves are known to be the largest single source

190 00:07:21.630 --> 00:07:22.553 and contributor.

191 00:07:23.640 --> 00:07:25.780 But this is perhaps I think to the neglect

192 00:07:25.780 --> 00:07:27.580 of many other contributors.

193 00:07:27.580 --> 00:07:30.463 And that's what I wanna focus on in this talk.

194 00:07:31.976 --> 00:07:32.809 (wind whooshing)

195 00:07:32.809 --> 00:07:33.820 (table creaking)

196 00:07:33.820 --> 00:07:35.190 The air pollution levels in cities,

197 00:07:35.190 --> 00:07:40.190 even average annual mean levels are astounding in cities

198 00:07:40.670 --> 00:07:41.820 across India.

199 00:07:41.820 --> 00:07:45.290 Not just the metropolitans like New Delhi and Mumbai.

200 00:07:45.290 --> 00:07:48.010 You're looking at smaller-medium sized cities

201 00:07:48.010 --> 00:07:50.400 that are in the range of one to 5 million as well.

202 00:07:50.400 --> 00:07:51.540 All of which,

203 00:07:51.540 --> 00:07:55.441 have mean concentration levels that not only exceed

204 00:07:55.441 --> 00:07:58.920 the WHO's guidelines of 10 micrograms per meter cube,

205 00:07:58.920 --> 00:08:03.520 but exceed the National Ambient Air Quality Standards

206 00:08:03.520 --> 00:08:05.103 as well, of 40.

207 00:08:06.060 --> 00:08:08.830 And, so the average over the year being so high,

208 00:08:08.830 --> 00:08:10.730 it tells you that in particular times of the year,

209 00:08:10.730 --> 00:08:12.280 this is even more than that,

210 00:08:12.280 --> 00:08:16.290 up to 300, 400 in certain times of the year as well.

211 00:08:16.290 --> 00:08:18.380 So, this is a serious problem,

212 00:08:18.380 --> 00:08:20.150 and this is only urban.

213 00:08:20.150 --> 00:08:21.910 The focus on rural areas tends to be,

214 00:08:21.910 --> 00:08:22.743 like I said,

215 00:08:22.743 --> 00:08:24.570 indoor air pollution from cookstoves.

216 00:08:24.570 --> 00:08:25.910 But as we'll see in the study,

217 00:08:25.910 --> 00:08:30.080 that there are also serious health risks to rural folks

218 00:08:30.080 --> 00:08:31.513 from air pollution as well.

219 00:08:33.070 --> 00:08:34.930 I wanted to briefly mention the New Delhi study,

220 00:08:34.930 --> 00:08:36.150 'cause I think it was insightful

221 00:08:36.150 --> 00:08:39.330 in terms of revealing the different sources of pollution.

222 00:08:39.330 --> 00:08:41.380 This is a study that was done by the air pollution group

223 00:08:41.380 --> 00:08:43.870 at IIASA using the GAINS Model.

224 00:08:43.870 --> 00:08:47.350 And, it shows that if you look at the different causes

225 00:08:47.350 --> 00:08:48.850 of air pollution in New Delhi;

226 00:08:49.760 --> 00:08:53.860 that it's a mix of sources that really,

227 00:08:53.860 --> 00:08:56.090 all of these sources contribute a fair amount.

228 00:08:56.090 --> 00:09:01.090 So, even dust from kicked up by construction work

229 00:09:02.020 --> 00:09:04.263 and by traffic is a significant component.

230 00:09:05.360 --> 00:09:09.140 Burning of bodies and fireworks are a significant component.

231 00:09:09.140 --> 00:09:11.970 Trash burning is extremely important.

232 00:09:11.970 --> 00:09:13.010 Residential cookstoves,

233 00:09:13.010 --> 00:09:16.923 even within and around New Delhi are a significant.

234 00:09:18.080 --> 00:09:19.332 And I said,

235 00:09:19.332 --> 00:09:22.420 this also includes kerosine and not just solid fuels.

236 00:09:22.420 --> 00:09:24.063 Power plants to a small extent.

237 00:09:24.930 --> 00:09:26.420 And a lot from agriculture,

238 00:09:26.420 --> 00:09:28.500 that is in the neighboring regions around Delhi.

239 00:09:28.500 --> 00:09:32.280 A lot of the pollution is from secondary inorganic PM.

240 00:09:32.280 --> 00:09:34.380 And then, this agricultural waste burning,

241 00:09:34.380 --> 00:09:35.213 as I mentioned,

242 00:09:35.213 --> 00:09:36.660 is just a small component.

243 00:09:36.660 --> 00:09:38.950 So really, if you look at all these sources,

244 00:09:38.950 --> 00:09:41.710 over 60% of air pollution in Delhi

245 00:09:41.710 --> 00:09:45.330 is from sources outside of the city center itself.

246 00:09:45.330 --> 00:09:47.710 And that's why it's really important to look at

247 00:09:47.710 --> 00:09:49.913 flows of air pollution across the country.

248 00:09:53.120 --> 00:09:55.220 Let me just give a brief overview of the literature,

249 00:09:55.220 --> 00:09:57.640 especially with relation to environmental justice.

250 00:09:57.640 --> 00:10:00.060 Because there has been a growing number of studies

251 00:10:00.060 --> 00:10:01.670 recently across the world,

252 00:10:01.670 --> 00:10:03.170 that try to understand this,

253 00:10:03.170 --> 00:10:07.630 the idea of our people facing a disproportionate exposure

254 00:10:07.630 --> 00:10:09.000 to air pollution.

255 00:10:09.000 --> 00:10:10.740 And so, we know that people who have studied

256 00:10:10.740 --> 00:10:11.590 health inequality,

257 00:10:11.590 --> 00:10:15.010 find that air pollution is a cause of health inequality

258 00:10:16.033 --> 00:10:18.623 in developing countries, by and large.

259 00:10:19.676 --> 00:10:22.100 And we find that at a global scale.

260 00:10:22.100 --> 00:10:24.950 And those health inequalities also have been associated

261 00:10:24.950 --> 00:10:27.780 with socioeconomic disparities.

262 00:10:27.780 --> 00:10:30.260 So, people of higher income levels

263 00:10:30.260 --> 00:10:33.320 suffer less health impacts from air pollution,

264 00:10:33.320 --> 00:10:34.820 than lower income levels.

265 00:10:34.820 --> 00:10:37.520 And this seems to hold in a lot of parts of the world,

266 00:10:37.520 --> 00:10:38.810 even in Europe.

267 00:10:38.810 --> 00:10:41.803 So, this is not just a developing country phenomenon.

268 00:10:42.964 --> 00:10:44.460 There are some exceptions such as in France,

269 00:10:44.460 --> 00:10:46.230 certain parts of Paris.

270 00:10:46.230 --> 00:10:47.063 You have rich neighborhoods

271 00:10:47.063 --> 00:10:48.650 that also have very high concentrations.

272 00:10:48.650 --> 00:10:49.483 But by and large,

273 00:10:49.483 --> 00:10:53.580 there seems to be a growing environmental justice concern

274 00:10:53.580 --> 00:10:55.500 about the relationship between air pollution,

275 00:10:55.500 --> 00:10:58.763 health inequality and socioeconomic inequality.

276 00:10:59.930 --> 00:11:02.230 We've seen this also in terms of international trade,

277 00:11:02.230 --> 00:11:06.760 that if you think about the air pollution that's exported,

278 00:11:06.760 --> 00:11:10.552 by importing products from countries

279 00:11:10.552 --> 00:11:12.500 where the air pollution impacts are felt.

280 00:11:12.500 --> 00:11:15.290 That also, is an important consideration.

281 00:11:15.290 --> 00:11:16.960 And China in particular,

282 00:11:16.960 --> 00:11:18.080 falls in that category

283 00:11:18.080 --> 00:11:21.260 because they provide the manufacturing capacity

284 00:11:21.260 --> 00:11:25.363 for large part of international consumption, by and large.

285 00:11:26.730 --> 00:11:28.140 There's only one study that I know of,

286 00:11:28.140 --> 00:11:30.220 that's the precedent for the one that I'm talking about.

287 00:11:30.220 --> 00:11:32.400 Which is a study in the U.S.

288 00:11:32.400 --> 00:11:35.180 that has actually looked at inequity in the consumption

289 00:11:35.180 --> 00:11:36.770 of goods and services.

290 00:11:36.770 --> 00:11:39.030 And found that there is a racial and ethnic dimension

291 00:11:39.030 --> 00:11:42.660 to the disparity in air pollution exposure.

292 00:11:42.660 --> 00:11:44.820 But this study also only goes so far

293 00:11:44.820 --> 00:11:46.750 as to look at consumption

294 00:11:46.750 --> 00:11:49.230 in relation to air pollution exposure

295 00:11:49.230 --> 00:11:51.730 for different household groups across the country.

296 00:11:52.770 --> 00:11:53.603 In our study,

297 00:11:53.603 --> 00:11:54.436 what we do is,

298 00:11:54.436 --> 00:11:56.680 we go further and look at mortality impacts.

299 00:11:56.680 --> 00:11:59.710 That is, we factor in the differential vulnerability

300 00:11:59.710 --> 00:12:02.420 of people to exposure,

301 00:12:02.420 --> 00:12:04.810 due in part to the different income levels.

302 00:12:04.810 --> 00:12:07.700 Which provide them with the ability to adapt

303 00:12:07.700 --> 00:12:10.400 or avoid different levels of air pollution.

304 00:12:10.400 --> 00:12:12.060 So, that's the unique aspect of the study

305 00:12:12.060 --> 00:12:14.610 that I'm gonna show you.

306 00:12:14.610 --> 00:12:16.740 Which is really looking all the way from consumption

307 00:12:16.740 --> 00:12:17.573 and sources,

308 00:12:17.573 --> 00:12:19.603 down to mortality risk.

309 00:12:22.247 --> 00:12:24.690 (table creaking)

310 00:12:24.690 --> 00:12:25.600 So, the question we asked,

311 00:12:25.600 --> 00:12:27.870 is can we attribute pollution sources to households

312 00:12:27.870 --> 00:12:29.570 through their consumption patterns?

313 00:12:29.570 --> 00:12:33.370 So the first challenges that the GAINS Model,

314 00:12:33.370 --> 00:12:34.220 The Air Pollution Model,

315 00:12:34.220 --> 00:12:37.930 know air pollution sources in terms of sectors.

316 00:12:37.930 --> 00:12:39.900 So, different industrial sectors,

317 00:12:39.900 --> 00:12:42.530 the transport sector, the household sector.

318 00:12:42.530 --> 00:12:45.410 But, how can we take that back,

319 00:12:45.410 --> 00:12:48.310 trace it back further to different household groups

320 00:12:48.310 --> 00:12:49.920 and their consumption patterns?

321 00:12:49.920 --> 00:12:52.380 So, now we need to understand and trace

322 00:12:52.380 --> 00:12:55.360 the different products and services from the sectors

323 00:12:55.360 --> 00:12:56.910 back to households.

324 00:12:56.910 --> 00:13:00.760 So that was one big challenge that I wanted to address.

325 00:13:00.760 --> 00:13:03.260 And that was one of the bridges that we wanted to build

326 00:13:03.260 --> 00:13:06.340 between the air pollution group and the energy group.

327 00:13:06.340 --> 00:13:07.940 And the second is that,

328 00:13:07.940 --> 00:13:09.890 Can we incorporate households vulnerability

329 00:13:09.890 --> 00:13:11.850 in translating exposure to mortality?

330 00:13:11.850 --> 00:13:16.230 'Cause we also wanted to account for the effect of income.

331 00:13:16.230 --> 00:13:18.150 Here we didn't have a lot of empirical evidence,

332 00:13:18.150 --> 00:13:21.910 but we did apply one paper that had some quantification

333 00:13:21.910 --> 00:13:24.210 of the role of income,

334 00:13:24.210 --> 00:13:26.130 but this was at a national scale.

335 00:13:26.130 --> 00:13:28.880 But we applied that to households across India as well.

336 00:13:30.775 --> 00:13:32.850 So, putting those books together,

337 00:13:32.850 --> 00:13:35.810 we found that it would be useful to organize households

338 00:13:35.810 --> 00:13:37.550 in terms of the income level;

339 00:13:37.550 --> 00:13:41.070 because the income level defines both consumption patterns,

340 00:13:41.070 --> 00:13:43.030 which we can then relate to industry.

341 00:13:43.030 --> 00:13:45.110 And income levels define also vulnerability.

342 00:13:45.110 --> 00:13:45.943 And so that would fall,

343 00:13:45.943 --> 00:13:47.670 it was a good organizing principle,

344 00:13:47.670 --> 00:13:49.490 in order to look at households

345 00:13:49.490 --> 00:13:52.370 and the both sides of the pollution equation.

346 00:13:52.370 --> 00:13:53.700 And so that's what we did.

347 00:13:53.700 --> 00:13:57.260 We looked at household deciles across the country.

348 00:13:57.260 --> 00:14:00.320 So, here is the complex modeling environment.

349 00:14:00.320 --> 00:14:03.263 And I wanted to spend a little time going through this.

350 00:14:04.590 --> 00:14:05.960 So, if I start on the impact side,

351 00:14:05.960 --> 00:14:08.693 which I think most of you might be better,

352 00:14:09.540 --> 00:14:11.260 more well versed than I am.

353 00:14:11.260 --> 00:14:13.713 So, this is not my primary expertise.

354 00:14:14.750 --> 00:14:17.140 So, we looked at mortality by the decile.

355 00:14:17.140 --> 00:14:19.850 And the main innovation was to apply

356 00:14:19.850 --> 00:14:21.310 this vulnerability by decile.

357 00:14:21.310 --> 00:14:22.143 As I mentioned,

358 00:14:23.141 --> 00:14:25.640 higher income groups have lower vulnerability.

359 00:14:25.640 --> 00:14:30.640 And then we used standard concentration response functions

360 00:14:31.540 --> 00:14:36.130 using spatially explicit PM2.5 concentrations,

361 00:14:36.130 --> 00:14:37.520 the grid level.

362 00:14:37.520 --> 00:14:41.463 And then exposure by age, sex and location;

363 00:14:42.590 --> 00:14:43.730 urban or rural,

364 00:14:43.730 --> 00:14:44.913 and by state.

365 00:14:45.920 --> 00:14:48.710 In order to determine the mortality

366 00:14:48.710 --> 00:14:51.200 associated with a given concentration

367 00:14:51.200 --> 00:14:54.050 at different geographic parts of the country.

368 00:14:54.050 --> 00:14:57.170 Now, what was important here is the caveat;

369 00:14:57.170 --> 00:14:58.570 which is that,

370 00:14:58.570 --> 00:15:01.030 while we know the distribution of income

371 00:15:01.030 --> 00:15:02.900 across states in India,

372 00:15:02.900 --> 00:15:05.580 the surveys don't give us a reliable enough estimate

373 00:15:05.580 --> 00:15:08.060 of the distribution of income within a state,

374 00:15:08.060 --> 00:15:10.360 except urban and rural.

375 00:15:10.360 --> 00:15:13.310 So, how are the different income deciles distributed

376 00:15:13.310 --> 00:15:15.550 within rural India,

377 00:15:15.550 --> 00:15:16.610 in a particular state?

378 00:15:16.610 --> 00:15:17.510 We don't quite know.

379 00:15:17.510 --> 00:15:18.350 So what that meant,

380 00:15:18.350 --> 00:15:22.550 is all rural residents in any given state

381 00:15:22.550 --> 00:15:24.470 had the same exposure.

382 00:15:24.470 --> 00:15:27.050 We can't differentiate exposure based on income level

383 00:15:27.050 --> 00:15:30.540 within urban-rural regions within a state.

384 00:15:30.540 --> 00:15:32.910 However, we do have differential exposures

385 00:15:32.910 --> 00:15:35.940 in different states in urban and rural areas,

386 00:15:35.940 --> 00:15:37.210 based on a number of factors;

387 00:15:37.210 --> 00:15:39.930 including where pollution sources are located.

388 00:15:39.930 --> 00:15:41.440 How income is distributed, et cetera.

389 00:15:41.440 --> 00:15:44.143 As I'll mention a little bit more later.

390 00:15:45.290 --> 00:15:46.470 On the contribution side,

391 00:15:46.470 --> 00:15:49.480 the contribution pathway was where we needed an innovation

392 00:15:49.480 --> 00:15:53.290 to link the household survey and consumption by decile

393 00:15:55.192 --> 00:15:57.790 to the final sectors,

394 00:15:57.790 --> 00:15:59.770 which the GAINS Air Pollution understands.

395 00:15:59.770 --> 00:16:02.930 So, let me just spend a minute on this intermediate section.

396 00:16:02.930 --> 00:16:04.970 The three sources of pollution

397 00:16:04.970 --> 00:16:06.230 from a consumption perspective.

398 00:16:06.230 --> 00:16:08.510 There's the direct use by fuels.

399 00:16:08.510 --> 00:16:12.470 So, that's cookstoves and heating fuels

400 00:16:12.470 --> 00:16:14.100 that are burned directly in the household,

401 00:16:14.100 --> 00:16:15.680 As our scope one.

402 00:16:15.680 --> 00:16:18.150 Emissions from the IPCC's language.

403 00:16:18.150 --> 00:16:21.470 And there's transport and electricity is also use fuels

404 00:16:21.470 --> 00:16:24.040 and household expenditure on fuels.

405 00:16:24.040 --> 00:16:27.330 The fuels being gasoline, diesel and electricity.

406 00:16:27.330 --> 00:16:28.770 But the emissions are elsewhere.

407 00:16:28.770 --> 00:16:31.186 So, that's scope two emissions.

408 00:16:31.186 --> 00:16:32.019 And then the third,

409 00:16:32.019 --> 00:16:34.310 is where the consumed goods and services

410 00:16:35.480 --> 00:16:39.710 and lead our trigger air pollution through the manufacturing

411 00:16:39.710 --> 00:16:41.830 of those products and services.

412 00:16:41.830 --> 00:16:46.330 And so, that's where we use extended input-output analysis.

413 00:16:46.330 --> 00:16:48.330 A multi-regional in-product put analysis

414 00:16:48.330 --> 00:16:50.140 that ultimately counts for trade.

415 00:16:50.140 --> 00:16:53.120 To be able to link household survey products

416 00:16:53.120 --> 00:16:55.550 to industry sectors.

417 00:16:55.550 --> 00:16:59.180 Now, this mechanism I had already developed

418 00:16:59.180 --> 00:17:00.460 in my own research.

419 00:17:00.460 --> 00:17:02.510 That is, to be able to do household footprinting

420 00:17:02.510 --> 00:17:05.710 of energy use for different products.

421 00:17:05.710 --> 00:17:07.390 But what we had to do was to extend this,

422 00:17:07.390 --> 00:17:10.840 to create BM2.5 satellite matrix.

423 00:17:10.840 --> 00:17:13.380 And the satellite matrix that we had to map

424 00:17:13.380 --> 00:17:16.960 are input-output sectors directly to the sectors in GAINS.

425 00:17:16.960 --> 00:17:20.380 And that was one of the bridges that we had to build.

426 00:17:20.380 --> 00:17:21.650 And with that,

427 00:17:21.650 --> 00:17:23.370 we were then were able to create

428 00:17:25.078 --> 00:17:28.733 a population weighted national, PM2.5 concentrations,

429 00:17:29.970 --> 00:17:31.660 based on all of the sectors.

430 00:17:31.660 --> 00:17:35.080 But then attribute that to deciles,

431 00:17:35.080 --> 00:17:36.823 income deciles in the country.

432 00:17:38.110 --> 00:17:41.470 Based on the basket of goods and services

433 00:17:41.470 --> 00:17:43.830 that each decile consumed.

434 00:17:43.830 --> 00:17:44.663 So, as you can imagine,

435 00:17:44.663 --> 00:17:47.580 lower income groups tend to consume less stuff,

436 00:17:47.580 --> 00:17:50.770 but they're using a lot more direct fuel.

437 00:17:50.770 --> 00:17:52.170 Whereas higher income groups

438 00:17:52.170 --> 00:17:54.240 don't use any direct fuel at all.

439 00:17:54.240 --> 00:17:56.120 They use electricity.

440 00:17:56.120 --> 00:17:57.570 And of course, they drive cars,

441 00:17:57.570 --> 00:17:59.320 but they consume a lot of stuff.

442 00:17:59.320 --> 00:18:01.230 And so, that's how we wanna kind of see

443 00:18:01.230 --> 00:18:03.180 how they play out in terms of the net effect

444 00:18:03.180 --> 00:18:05.480 of air pollution from these different sources.

445 00:18:07.580 --> 00:18:10.200 Just a quick deep dive for the GAINS Model.

446 00:18:10.200 --> 00:18:12.500 Again, I think a lot of you are familiar with this.

447 00:18:12.500 --> 00:18:14.600 They have a very detailed representation

448 00:18:14.600 --> 00:18:17.710 of point sources of pollution across the country.

449 00:18:17.710 --> 00:18:20.220 Including a spatial representation

450 00:18:20.220 --> 00:18:22.020 from all the sectors in the economy.

451 00:18:22.990 --> 00:18:24.603 Industry transport households.

452 00:18:25.900 --> 00:18:28.380 And they also model end-of-pipe solutions

453 00:18:28.380 --> 00:18:30.080 for all of these different sources;

454 00:18:30.080 --> 00:18:32.700 pollution control, their different costs.

455 00:18:32.700 --> 00:18:34.630 The greenhouse gas emission applications as well,

456 00:18:34.630 --> 00:18:38.240 and a set of different air pollutants.

457 00:18:38.240 --> 00:18:41.760 And they have the ability to define scenarios,

458 00:18:41.760 --> 00:18:43.750 scenarios of control technologies,

459 00:18:43.750 --> 00:18:46.220 applied to different activities in the economy.

460 00:18:46.220 --> 00:18:47.860 And based on the emissions factors

461 00:18:47.860 --> 00:18:49.990 and links to a dispersion,

462 00:18:49.990 --> 00:18:52.010 atmospheric dispersion model.

463 00:18:52.010 --> 00:18:54.370 You can see the effects of controls

464 00:18:54.370 --> 00:18:57.060 on pollution concentrations in different parts

465 00:18:57.060 --> 00:18:57.893 of the country.

466 00:18:59.150 --> 00:19:01.240 And then, look at the effects on mortality

467 00:19:01.240 --> 00:19:02.940 using standard dose response functions

468 00:19:02.940 --> 00:19:04.970 from the Global Burden of Disease.

469 00:19:04.970 --> 00:19:09.550 And then, you could iterate in order to determine

470 00:19:09.550 --> 00:19:11.350 if we had to limit the number

471 00:19:11.350 --> 00:19:14.150 of the extent of health impacts.

472 00:19:14.150 --> 00:19:17.410 What scenarios of pollution control could bring us there?

473 00:19:17.410 --> 00:19:21.030 So, we will be utilizing some of this scenario technology

474 00:19:21.030 --> 00:19:22.273 in this study as well.

475 00:19:26.810 --> 00:19:28.010 So, the direct sources,

476 00:19:28.010 --> 00:19:29.230 as I mentioned.

477 00:19:29.230 --> 00:19:33.180 It was important to understand what households

478 00:19:33.180 --> 00:19:34.560 use what kind of cooking fuels.

479 00:19:34.560 --> 00:19:37.423 Now, we have this data from household surveys.

480 00:19:38.310 --> 00:19:40.890 So, we have an understanding of the demand curves,

481 00:19:40.890 --> 00:19:42.266 if you will,

482 00:19:42.266 --> 00:19:44.450 for different types of households in urban and rural areas,

483 00:19:44.450 --> 00:19:46.123 and off different income levels.

484 00:19:47.136 --> 00:19:50.640 And understanding at what price point they would switch

485 00:19:50.640 --> 00:19:53.490 from gas back to biomass, for example.

486 00:19:53.490 --> 00:19:56.570 So, we have a detailed understanding of what households use

487 00:19:56.570 --> 00:19:57.773 what kind of fuels.

488 00:19:59.710 --> 00:20:01.010 But we had to do a little bit of work

489 00:20:01.010 --> 00:20:04.500 to understand the travel modes for different households,

490 00:20:04.500 --> 00:20:06.330 at different income levels.

491 00:20:06.330 --> 00:20:08.020 Who travels by bus and by rail?

492 00:20:08.020 --> 00:20:09.310 And who has a car?

493 00:20:09.310 --> 00:20:13.530 In order to determine the indirect impact of air pollution

494 00:20:13.530 --> 00:20:16.433 through the transport means of the vehicles that they use.

495 00:20:17.960 --> 00:20:19.210 And the same with electricity,

496 00:20:19.210 --> 00:20:22.490 depending upon how much electricity households use.

497 00:20:22.490 --> 00:20:26.930 The power plant in GAINS would tell us the extent to which

498 00:20:26.930 --> 00:20:28.630 they cause air pollution in power plants,

499 00:20:28.630 --> 00:20:30.640 through their use of appliances

500 00:20:30.640 --> 00:20:32.883 and electronic gadgets at home.

501 00:20:33.900 --> 00:20:37.490 So, that was the two main direct sources.

502 00:20:37.490 --> 00:20:38.590 The scope one and scope two,

503 00:20:38.590 --> 00:20:39.860 as I mentioned.

504 00:20:39.860 --> 00:20:40.860 And then the scope three,

505 00:20:40.860 --> 00:20:43.770 is this household footprinting technique.

506 00:20:43.770 --> 00:20:47.070 Which is a very large number crunching exercise.

507 00:20:47.070 --> 00:20:50.670 Where you have to link household consumption surveys

508 00:20:50.670 --> 00:20:54.380 and map them into a certain industry standard category

509 00:20:54.380 --> 00:20:56.193 called COICOP used in Europe.

510 00:20:57.330 --> 00:21:00.320 And match them to the sectors in the industry

511 00:21:00.320 --> 00:21:02.540 and put output database,

512 00:21:02.540 --> 00:21:05.710 match prices and other fun stuff,

513 00:21:05.710 --> 00:21:08.130 that allows you to create a total embodied energy

514 00:21:08.130 --> 00:21:10.490 that's induced by every unit of consumption

515 00:21:10.490 --> 00:21:12.380 from different products and services.

516 00:21:12.380 --> 00:21:13.806 So like I said,

517 00:21:13.806 --> 00:21:17.440 this is a methodology we'd already developed before.

518 00:21:17.440 --> 00:21:19.720 And the idea was just to link this

519 00:21:19.720 --> 00:21:21.070 to the air pollution model.

520 00:21:23.000 --> 00:21:24.350 One last thing on methodology,

521 00:21:24.350 --> 00:21:26.860 just to provide some sense of the results.

522 00:21:26.860 --> 00:21:28.260 This is a slightly old,

523 00:21:28.260 --> 00:21:31.270 but illustrative graph of the average air pollution

524 00:21:31.270 --> 00:21:32.800 across the country.

525 00:21:32.800 --> 00:21:33.810 And the point is,

526 00:21:33.810 --> 00:21:35.343 that location doesn't matter.

527 00:21:37.290 --> 00:21:40.140 You're seeing here that the average concentrations in India

528 00:21:40.140 --> 00:21:43.400 tend to increase as you go northward.

529 00:21:43.400 --> 00:21:46.763 And this is because of temperature inversions, by and large.

530 00:21:48.741 --> 00:21:51.170 And also because there is a very high concentration

531 00:21:51.170 --> 00:21:53.530 of polluting power plants.

532 00:21:53.530 --> 00:21:56.320 So, mainly the coal belt is largely in the north

533 00:21:56.320 --> 00:21:57.680 and the Northeast.

534 00:21:57.680 --> 00:21:59.780 And so, the combination of those make it unlikely

535 00:21:59.780 --> 00:22:01.500 for people who live in the north.

536 00:22:01.500 --> 00:22:02.333 And so they,

537 00:22:02.333 --> 00:22:04.200 you can imagine that the distribution of people,

538 00:22:04.200 --> 00:22:07.930 if it's the extent to which people are rural and poor,

539 00:22:07.930 --> 00:22:09.330 and live in the north,

540 00:22:09.330 --> 00:22:11.210 they would face a higher level of pollution,

541 00:22:11.210 --> 00:22:12.900 all as equal.

542 00:22:12.900 --> 00:22:15.240 You also can see that the urban centers,

543 00:22:15.240 --> 00:22:17.320 the little dots spread across the map

544 00:22:17.320 --> 00:22:20.300 are also much higher concentrations of pollution,

545 00:22:20.300 --> 00:22:23.160 because of additional sources of pollution in the cities

546 00:22:23.160 --> 00:22:24.660 and in the urban areas.

547 00:22:24.660 --> 00:22:28.260 And that also tells us that the distribution of population

548 00:22:28.260 --> 00:22:30.093 in different urban areas also,

549 00:22:31.043 --> 00:22:33.515 and their income distribution reflects,

550 00:22:33.515 --> 00:22:36.440 or has an impact on who ultimately faces mortality

551 00:22:36.440 --> 00:22:39.103 from all of these combined sources of air pollution.

552 00:22:41.780 --> 00:22:44.510 We did create this pollution inequity index,

553 00:22:44.510 --> 00:22:47.740 which is mortality risk per unit

554 00:22:47.740 --> 00:22:51.660 of contribution to PM concentrations.

555 00:22:51.660 --> 00:22:52.730 It's a bit of a mouthful.

556 00:22:52.730 --> 00:22:54.580 And perhaps not intuitive.

557 00:22:54.580 --> 00:22:55.760 But the reason why we did that

558 00:22:55.760 --> 00:22:57.650 was we can then compare this index

559 00:22:57.650 --> 00:22:59.160 at different income levels.

560 00:22:59.160 --> 00:23:02.310 In order to look at the relative injustice,

561 00:23:02.310 --> 00:23:03.143 if you will,

562 00:23:03.143 --> 00:23:04.250 for different income groups.

563 00:23:04.250 --> 00:23:06.980 The extent to which they are facing higher mortality

564 00:23:06.980 --> 00:23:08.490 per unit of their contribution

565 00:23:08.490 --> 00:23:10.910 to the source of that mortality.

566 00:23:10.910 --> 00:23:13.110 So, that's what we used as well

567 00:23:13.110 --> 00:23:15.423 to try and illustrate the extent of inequity.

568 00:23:17.360 --> 00:23:19.360 Okay, so now let me move to the results.

569 00:23:21.030 --> 00:23:24.000 Let me start with discussing the contributions,

570 00:23:24.000 --> 00:23:26.460 without looking at impacts yet.

571 00:23:26.460 --> 00:23:28.520 So, let me start with the leftmost average bar.

572 00:23:28.520 --> 00:23:30.200 This itself was insightful.

573 00:23:30.200 --> 00:23:33.590 So, this is the total average PM concentrations

574 00:23:33.590 --> 00:23:36.290 and their broad source categories.

575 00:23:36.290 --> 00:23:38.550 So, the lowest one is household cooking fuels.

576 00:23:38.550 --> 00:23:42.243 So, this is primarily solid fuel burning.

577 00:23:45.290 --> 00:23:47.570 And this is already something that we learned new.

578 00:23:47.570 --> 00:23:49.170 So, we generally have the impression

579 00:23:49.170 --> 00:23:53.740 that 30 to 50% of PM2.5 in India,

580 00:23:53.740 --> 00:23:55.713 it comes from solid fuel burning.

581 00:23:56.880 --> 00:23:58.320 But if you look at this green bar,

582 00:23:58.320 --> 00:24:01.600 this is including scope two and scope three emissions.

583 00:24:01.600 --> 00:24:06.050 And, so this household consumption other than cooking

584 00:24:06.050 --> 00:24:07.520 and heating fuels,

585 00:24:07.520 --> 00:24:11.763 is actually a much higher than cookstoves.

586 00:24:12.970 --> 00:24:14.256 So in fact,

587 00:24:14.256 --> 00:24:15.089 it's about 40 to 60%

588 00:24:15.089 --> 00:24:16.990 just if you look at household consumption.

589 00:24:16.990 --> 00:24:21.090 So overall, the indirect household consumption

590 00:24:21.090 --> 00:24:23.310 actually is causing more overall pollution

591 00:24:23.310 --> 00:24:25.353 than does cookstoves alone.

592 00:24:26.340 --> 00:24:27.230 The other interesting thing,

593 00:24:27.230 --> 00:24:32.000 is to see that these non-household consumption.

594 00:24:32.000 --> 00:24:34.730 So, this is government expenditure

595 00:24:34.730 --> 00:24:37.220 called industrial manufacturing;

596 00:24:37.220 --> 00:24:39.000 things like defense,

597 00:24:39.000 --> 00:24:40.850 as well as capital formation.

598 00:24:40.850 --> 00:24:43.050 That's not included in household consumption,

599 00:24:43.050 --> 00:24:44.413 contributes a fair amount,

600 00:24:45.755 --> 00:24:47.770 of the order for a quarter of total air pollution.

601 00:24:47.770 --> 00:24:49.360 And then a big chunk of air pollution

602 00:24:49.360 --> 00:24:50.680 is from natural sources,

603 00:24:50.680 --> 00:24:52.910 like dust, as well as trans-boundary sources.

604 00:24:52.910 --> 00:24:54.930 So, even from Pakistan, for example.

605 00:24:54.930 --> 00:24:57.650 So, all the solutions that we have got,

606 00:24:57.650 --> 00:24:59.090 that I'm gonna show you in this scenarios

607 00:24:59.090 --> 00:25:02.480 can really only addressed 50 to 60% of air pollution

608 00:25:03.360 --> 00:25:04.480 in the country.

609 00:25:04.480 --> 00:25:06.870 So, there's a limit to which we can reduce mortality

610 00:25:06.870 --> 00:25:08.430 just from this study;

611 00:25:08.430 --> 00:25:11.720 from reducing air pollution from household consumption

612 00:25:11.720 --> 00:25:12.553 in particular.

613 00:25:13.683 --> 00:25:14.516 Now, if you look at the right hand side,

614 00:25:14.516 --> 00:25:16.160 we're showing you by decile

615 00:25:16.160 --> 00:25:18.990 with increasing income moving to the right.

616 00:25:18.990 --> 00:25:21.290 The different sources of air pollution

617 00:25:21.290 --> 00:25:22.660 and their contributions.

618 00:25:22.660 --> 00:25:23.560 So you can,

619 00:25:23.560 --> 00:25:27.580 it's intuitive to know that the lowest income households,

620 00:25:27.580 --> 00:25:30.283 their biggest contributor is cooking and heating.

621 00:25:31.850 --> 00:25:34.490 Whereas if you look at the top decile,

622 00:25:34.490 --> 00:25:37.460 they don't cook with biomass very much.

623 00:25:37.460 --> 00:25:38.940 You still have some biomass use

624 00:25:38.940 --> 00:25:40.480 because there are some rural folks

625 00:25:40.480 --> 00:25:43.463 who still fall into the top decile.

626 00:25:44.560 --> 00:25:47.490 Even though it's dominated by urban residents.

627 00:25:47.490 --> 00:25:49.000 And you see that there's,

628 00:25:49.000 --> 00:25:50.740 electricity usage is significant.

629 00:25:50.740 --> 00:25:52.470 So that's power plant emissions.

630 00:25:52.470 --> 00:25:53.900 And passenger transport,

631 00:25:53.900 --> 00:25:56.990 which is very high because people all own cars over here.

632 00:25:56.990 --> 00:26:01.010 And so their individual per capita emissions have very high.

633 00:26:01.010 --> 00:26:02.210 What was very surprising to us,

634 00:26:02.210 --> 00:26:05.140 is the extent in the contribution of food and food waste.

635 00:26:05.140 --> 00:26:06.850 This is food production.

636 00:26:06.850 --> 00:26:09.883 Things like fertilizer use and nitrous oxide and ammonia.

637 00:26:10.830 --> 00:26:13.360 As well as the fossil use for machinery and transport,

638 00:26:13.360 --> 00:26:14.193 and agriculture,

639 00:26:14.193 --> 00:26:16.470 is all reflected in the light green.

640 00:26:16.470 --> 00:26:19.810 Whereas the dark green is reflecting food waste.

641 00:26:19.810 --> 00:26:22.244 That's the burning of food waste,

642 00:26:22.244 --> 00:26:23.770 and that's thrown out in the open.

643 00:26:23.770 --> 00:26:28.770 As well as the municipal waste burning for incineration.

644 00:26:29.120 --> 00:26:30.970 That's a significant contributor

645 00:26:30.970 --> 00:26:34.490 and we attribute waste to households in proportion

646 00:26:34.490 --> 00:26:35.690 to their consumption of food.

647 00:26:35.690 --> 00:26:37.570 And that's why this is proportionate

648 00:26:37.570 --> 00:26:39.980 to the food related air pollution.

649 00:26:39.980 --> 00:26:41.346 And finally,

650 00:26:41.346 --> 00:26:43.490 the other stuff in terms of products and services;

651 00:26:43.490 --> 00:26:45.010 actually it was surprising to us

652 00:26:45.010 --> 00:26:47.360 to be at a smaller contributor than we thought.

653 00:26:49.620 --> 00:26:51.130 So clearly, there's here a trade-off.

654 00:26:51.130 --> 00:26:54.313 So, low-income households are contributing to air pollution

655 00:26:54.313 --> 00:26:55.420 through their cookstove use.

656 00:26:55.420 --> 00:26:57.220 And high-income households are contributing

657 00:26:57.220 --> 00:26:58.840 through their other indirect use;

658 00:26:58.840 --> 00:27:01.133 food, transport, electricity and other stuff.

659 00:27:03.250 --> 00:27:05.840 Just a quick look at urban and rural differences.

660 00:27:05.840 --> 00:27:07.190 So, if you look per decile.

661 00:27:08.660 --> 00:27:10.510 This is the contribution of urban households

662 00:27:10.510 --> 00:27:12.643 to the deciles in aggregate.

663 00:27:14.016 --> 00:27:15.610 And, clearly you see that the highest deciles

664 00:27:15.610 --> 00:27:18.810 tend to contribute the most from urban areas

665 00:27:18.810 --> 00:27:21.690 because rich people tend to be in urban areas in India.

666 00:27:21.690 --> 00:27:23.170 That's really what we're showing.

667 00:27:23.170 --> 00:27:24.790 Whereas in rural areas,

668 00:27:24.790 --> 00:27:26.390 you tend to have fewer people contributing

669 00:27:26.390 --> 00:27:27.660 to the higher deciles.

670 00:27:29.020 --> 00:27:30.460 The other thing is to,

671 00:27:30.460 --> 00:27:32.068 if you look at it per capita basis;

672 00:27:32.068 --> 00:27:34.200 so not looking at the aggregate contribution to deciles.

673 00:27:34.200 --> 00:27:36.471 You notice that in urban areas,

674 00:27:36.471 --> 00:27:37.304 that by and large,

675 00:27:37.304 --> 00:27:38.230 as you go,

676 00:27:38.230 --> 00:27:40.090 as you increase your income level,

677 00:27:40.090 --> 00:27:41.670 your overall contribution to air pollution

678 00:27:41.670 --> 00:27:42.780 isn't increasing very much.

679 00:27:42.780 --> 00:27:46.210 It's really in the highest decile

680 00:27:46.210 --> 00:27:49.220 where you see the biggest change in consumption levels.

681 00:27:49.220 --> 00:27:52.420 And therefore, the biggest impact on air pollution.

682 00:27:52.420 --> 00:27:53.430 Whereas in rural areas,

683 00:27:53.430 --> 00:27:55.960 there's a steady increase in air pollution.

684 00:27:55.960 --> 00:27:59.533 Despite the fact that there is a reduction

685 00:27:59.533 --> 00:28:00.600 in cookstove use.

686 00:28:00.600 --> 00:28:03.920 And, so that tells you that the consumption is offsetting

687 00:28:03.920 --> 00:28:06.080 the reduction in the air pollution from cookstoves.

688 00:28:06.080 --> 00:28:07.890 Even in rural areas,

689 00:28:07.890 --> 00:28:09.973 where cookstove use dominates.

690 00:28:11.370 --> 00:28:13.970 So, now we move a little bit more to the impact side.

691 00:28:13.970 --> 00:28:16.360 So, now we're looking at contributions versus mortality.

692 00:28:16.360 --> 00:28:18.493 If you just focus on the black lines here.

693 00:28:21.502 --> 00:28:22.980 The highest deciles are to the right.

694 00:28:22.980 --> 00:28:25.630 So, the contribution curve is the one sloping upward.

695 00:28:26.773 --> 00:28:28.530 And you see that higher income groups

696 00:28:28.530 --> 00:28:33.500 contribute significantly more to PM concentrations

697 00:28:33.500 --> 00:28:35.290 than do lower income groups;

698 00:28:35.290 --> 00:28:37.520 by a factor of three or so.

699 00:28:37.520 --> 00:28:39.900 And if you look at the dotted black line,

700 00:28:39.900 --> 00:28:42.640 that is showing you the mortality impacts.

701 00:28:42.640 --> 00:28:46.220 So, the lowest income group based on mortality impact

702 00:28:46.220 --> 00:28:49.073 for about 200 premature deaths per a hundred thousand.

703 00:28:50.010 --> 00:28:51.810 This is ambient air pollution alone.

704 00:28:52.955 --> 00:28:55.120 Compared to less than one.

705 00:28:55.120 --> 00:28:57.990 That's a factor of four difference in terms of the mortality

706 00:28:57.990 --> 00:28:59.620 going in the opposite direction.

707 00:28:59.620 --> 00:29:01.040 So you can see here,

708 00:29:01.040 --> 00:29:02.840 this is a kind of headline figure

709 00:29:02.840 --> 00:29:06.740 in terms of the inequity that households are

710 00:29:06.740 --> 00:29:09.930 in low-income decile are contributing so much less,

711 00:29:09.930 --> 00:29:11.353 but facing so much more.

712 00:29:12.856 --> 00:29:13.689 And this is from all different sources.

713 00:29:13.689 --> 00:29:16.000 This is separate from the indoor air pollution

714 00:29:16.000 --> 00:29:17.260 they face from cookstoves.

715 00:29:17.260 --> 00:29:18.860 This is just looking at ambient.

716 00:29:20.562 --> 00:29:21.550 And the blue and the red lines are showing you

717 00:29:21.550 --> 00:29:26.290 the rural and urban households in particular.

718 00:29:26.290 --> 00:29:28.943 And you'll see that they converge.

719 00:29:31.122 --> 00:29:32.460 So, the rural households are dominating

720 00:29:32.460 --> 00:29:34.062 the low-income households,

721 00:29:34.062 --> 00:29:34.895 and the urban households are dominating

722 00:29:34.895 --> 00:29:35.950 the high-income households,

723 00:29:35.950 --> 00:29:37.370 as I showed you earlier.

724 00:29:41.010 --> 00:29:43.760 (table creaking)

725 00:29:45.679 --> 00:29:47.135 Now, we want you to look and isolate

726 00:29:47.135 --> 00:29:48.964 some of the different sources of pollution.

727 00:29:48.964 --> 00:29:51.140 So, we developed two scenarios.

728 00:29:51.140 --> 00:29:54.300 Which we posed as sort of clean up scenarios.

729 00:29:54.300 --> 00:29:56.820 So, you have the clean cookstoves scenario,

730 00:29:56.820 --> 00:30:00.210 where holding everything else constant.

731 00:30:00.210 --> 00:30:02.812 We switched everybody to clean cookstoves.

732 00:30:02.812 --> 00:30:04.643 Which means either electric cookstoves,

733 00:30:06.115 --> 00:30:07.290 whose power plants were all green.

734 00:30:07.290 --> 00:30:12.290 So, they add literally no emissions from the stoves.

735 00:30:12.450 --> 00:30:14.680 But we kept everything else constant.

736 00:30:14.680 --> 00:30:16.570 And the other scenario,

737 00:30:16.570 --> 00:30:19.510 we implemented end-of-pipe solutions

738 00:30:19.510 --> 00:30:20.700 on all other sectors,

739 00:30:20.700 --> 00:30:22.063 except cookstoves.

740 00:30:23.400 --> 00:30:26.900 To the maximum extent of available technologies globally.

741 00:30:26.900 --> 00:30:28.723 So, actually we used Germany.

742 00:30:29.984 --> 00:30:32.571 And, so technology frontier in Germany.

743 00:30:32.571 --> 00:30:33.820 For example, Euro 6 norms for vehicles,

744 00:30:33.820 --> 00:30:35.230 If I remember correctly.

745 00:30:35.230 --> 00:30:37.853 So, very, very stringent controls,

746 00:30:38.740 --> 00:30:41.840 not really considering costs in this particular study

747 00:30:41.840 --> 00:30:43.440 and applied those.

748 00:30:43.440 --> 00:30:45.333 So, what this allowed us to do,

749 00:30:46.889 --> 00:30:49.770 really was to isolate the air pollution impacts

750 00:30:49.770 --> 00:30:53.323 and their distribution from these two sets of sources.

751 00:30:54.352 --> 00:30:55.803 So, in the clean cook source scenario,

752 00:30:55.803 --> 00:30:56.940 when I show you the results in red;

753 00:30:56.940 --> 00:30:59.051 you will see the impact,

754 00:30:59.051 --> 00:31:01.660 the distributional impact of the scope two

755 00:31:01.660 --> 00:31:03.930 and scope three sources.

756 00:31:03.930 --> 00:31:06.570 Which are dominated by higher income groups.

757 00:31:06.570 --> 00:31:08.230 Whereas in the MCO scenario,

758 00:31:08.230 --> 00:31:09.753 which you gonna see in blue;

759 00:31:11.070 --> 00:31:12.390 you're gonna isolate the distributive impact

760 00:31:12.390 --> 00:31:15.313 of dirty cookstoves through ambient air pollution.

761 00:31:17.840 --> 00:31:21.050 So, first I'm showing you what I think is already a pattern

762 00:31:21.050 --> 00:31:21.993 from the previous slides.

763 00:31:21.993 --> 00:31:23.150 Which is this the contributions.

764 00:31:23.150 --> 00:31:28.150 So, their reduction that you get from the clean cookstoves

765 00:31:28.950 --> 00:31:30.260 are shown in red.

766 00:31:30.260 --> 00:31:33.970 And from the end-of-pipe in the rest of the economy in blue.

767 00:31:33.970 --> 00:31:38.480 And you see that the contributions reduce the most

768 00:31:38.480 --> 00:31:40.050 for lower-income groups,

769 00:31:40.050 --> 00:31:41.943 when you impose clean cookstoves.

770 00:31:42.984 --> 00:31:44.010 Which makes sense because they are the higher users

771 00:31:44.010 --> 00:31:46.390 of dirty cookstoves.

772 00:31:46.390 --> 00:31:47.490 And like I mentioned,

773 00:31:47.490 --> 00:31:50.360 the rural households and the rich rural households

774 00:31:50.360 --> 00:31:52.694 still use biomass to some extent.

775 00:31:52.694 --> 00:31:54.470 So, you still have a little bit of that.

776 00:31:54.470 --> 00:31:56.781 But then if you look at the contributions

777 00:31:56.781 --> 00:31:57.623 from the other sectors,

778 00:31:57.623 --> 00:31:59.550 because lower income households don't consume a lot of stuff

779 00:31:59.550 --> 00:32:03.160 in terms of electrical gadgets or they don't have cars.

780 00:32:03.160 --> 00:32:05.223 And they don't consume a lot of stuff.

781 00:32:06.261 --> 00:32:08.240 Their reduction that they face

782 00:32:09.400 --> 00:32:10.923 in terms of contributions,

783 00:32:11.830 --> 00:32:14.420 not face the reductions in their contributions

784 00:32:14.420 --> 00:32:16.210 is lower than the reductions in contributions

785 00:32:16.210 --> 00:32:18.360 for higher income groups who consume a lot.

786 00:32:19.591 --> 00:32:20.424 Now, if we look at the impact side.

787 00:32:20.424 --> 00:32:23.963 This is the key insight in this study.

788 00:32:25.361 --> 00:32:27.630 The avoided mortality from the clean cookstove scenario

789 00:32:27.630 --> 00:32:31.113 is predictably much higher for lower income households.

790 00:32:32.783 --> 00:32:34.810 They're located in areas where there's more cookstove users.

791 00:32:34.810 --> 00:32:36.960 And so, the ambient air quality is much worse

792 00:32:36.960 --> 00:32:38.400 from the cookstoves.

793 00:32:38.400 --> 00:32:39.790 So, that's predictable.

794 00:32:39.790 --> 00:32:41.080 But what was not expected,

795 00:32:41.080 --> 00:32:44.750 is that the contribution from the ambient,

796 00:32:44.750 --> 00:32:46.190 from the other sources;

797 00:32:46.190 --> 00:32:48.163 industry, transport, electricity,

798 00:32:49.402 --> 00:32:50.235 also falls disproportionately

799 00:32:50.235 --> 00:32:51.860 on these lower income households.

800 00:32:53.130 --> 00:32:55.762 And that's in contrast to the contribution.

801 00:32:55.762 --> 00:32:58.522 So this is the impact side,

802 00:32:58.522 --> 00:32:59.355 and this is the contribution side.

803 00:32:59.355 --> 00:33:02.060 And you clearly see how the,

804 00:33:02.060 --> 00:33:05.250 it's the other consumption that is disproportionately

805 00:33:05.250 --> 00:33:06.690 affecting lower income households

806 00:33:06.690 --> 00:33:08.163 from ambient air pollution.

807 00:33:09.183 --> 00:33:11.171 And that is really the main insight from the study

808 00:33:11.171 --> 00:33:12.320 that we were not expecting.

809 00:33:12.320 --> 00:33:13.887 And as I mentioned,

810 00:33:13.887 --> 00:33:15.770 this has to do with where points offices are located,

811 00:33:15.770 --> 00:33:17.530 in relation to low-income households.

812 00:33:17.530 --> 00:33:19.550 It has something to do with the differences

813 00:33:19.550 --> 00:33:23.123 in urban and rural populations across the country.

814 00:33:23.123 --> 00:33:25.245 As well as this temperature inversion in the north.

815 00:33:25.245 --> 00:33:27.345 All of these contribute to this imbalance.

816 00:33:29.210 --> 00:33:31.533 If you look at this pollution inequity index,

817 00:33:33.134 --> 00:33:34.780 it may seem a little counterintuitive.

818 00:33:34.780 --> 00:33:39.640 But the red dots are showing you the inequity

819 00:33:40.864 --> 00:33:42.600 in the clean cooking scenario.

820 00:33:42.600 --> 00:33:46.980 Which means this is the inequity in just the other sources.

821 00:33:46.980 --> 00:33:48.730 And that's why you see here.

822 00:33:48.730 --> 00:33:52.168 The pollution inequity is much higher

823 00:33:52.168 --> 00:33:54.293 in this scenario where you have clean cookstoves.

824 00:33:56.279 --> 00:33:57.610 Because the ambient sources of their pollution

825 00:33:57.610 --> 00:33:59.690 are causing higher mortality disproportionately

826 00:33:59.690 --> 00:34:01.110 on lower income groups.

827 00:34:01.110 --> 00:34:04.500 Whereas the pollution inequity index is not as steep

828 00:34:04.500 --> 00:34:07.170 in the case where you clean up the rest of the economy

829 00:34:07.170 --> 00:34:08.520 and leave dirty cookstoves.

830 00:34:10.631 --> 00:34:11.464 So, that's really the key,

831 00:34:11.464 --> 00:34:12.297 the point here.

832 00:34:12.297 --> 00:34:15.653 Now, I wanted to make sure that we put it into context,

833 00:34:16.746 --> 00:34:19.171 mortality associated with ambient,

834 00:34:19.171 --> 00:34:20.741 compared to indoor air pollution.

835 00:34:20.741 --> 00:34:23.019 Because it still remains the case,

836 00:34:23.019 --> 00:34:25.400 that indoor air pollution really is the biggest problem

837 00:34:25.400 --> 00:34:28.005 in terms of mortality from air pollution.

838 00:34:28.005 --> 00:34:28.838 (creaking sound)

839 00:34:28.838 --> 00:34:29.671 Is the order of magnitude higher deaths

840 00:34:29.671 --> 00:34:32.220 that are caused by indoor air pollution?

841 00:34:32.220 --> 00:34:33.053 As you all know,

842 00:34:33.053 --> 00:34:34.950 the concentration levels are associated

843 00:34:36.504 --> 00:34:38.075 with cookstoves indoor.

844 00:34:38.075 --> 00:34:40.475 We take a 300 micrograms or more per meter cube.

845 00:34:42.120 --> 00:34:43.669 And so therefore,

846 00:34:43.669 --> 00:34:47.340 if you just look at the overall introduction in mortality

847 00:34:48.393 --> 00:34:49.897 from clean cookstoves,

848 00:34:49.897 --> 00:34:51.700 accounting also for indoor air pollution.

849 00:34:51.700 --> 00:34:54.630 Of course, you see that the lower income groups

850 00:34:54.630 --> 00:34:55.743 benefit the most.

851 00:34:56.890 --> 00:34:59.800 But that's really mostly from the indoor air pollution.

852 00:34:59.800 --> 00:35:04.188 The inequity from the outdoor air pollution in blue,

853 00:35:04.188 --> 00:35:05.430 you're still seeing as falling disproportionately

854 00:35:05.430 --> 00:35:07.330 on lower income households.

855 00:35:07.330 --> 00:35:09.630 You're just seeing that the in absolute terms,

856 00:35:10.552 --> 00:35:12.940 it's still a lot less than indoor air pollution

857 00:35:12.940 --> 00:35:14.398 related deaths.

858 00:35:14.398 --> 00:35:17.570 So, we wanted to make sure that we're not saying that

859 00:35:17.570 --> 00:35:19.980 clean cookstoves aren't as important to clean up,

860 00:35:19.980 --> 00:35:20.920 due to indoor air pollution.

861 00:35:20.920 --> 00:35:23.170 In fact, they still remain the most important

862 00:35:24.260 --> 00:35:25.093 mitigation measure.

863 00:35:27.008 --> 00:35:28.724 So, I just wanted to put that into context.

864 00:35:28.724 --> 00:35:29.557 (button clicking)

865 00:35:29.557 --> 00:35:32.363 So, just to conclude,

866 00:35:33.739 --> 00:35:36.719 the cookstove contributions,

867 00:35:36.719 --> 00:35:38.970 we found some interesting insights.

868 00:35:38.970 --> 00:35:41.300 Namely, that the contribution to ambient air pollution

869 00:35:41.300 --> 00:35:43.439 is 40% of that,

870 00:35:43.439 --> 00:35:44.272 of the other sources;

871 00:35:44.272 --> 00:35:46.710 that is triggered by household consumption.

872 00:35:46.710 --> 00:35:50.120 And that's ignoring transplant resources, natural sources,

873 00:35:50.120 --> 00:35:54.467 as well as government related pollution.

874 00:35:54.467 --> 00:35:57.023 As well as capital formation.

875 00:35:58.724 --> 00:36:01.755 So, that itself is an insight that we need to think about

876 00:36:01.755 --> 00:36:03.444 the household contributions to air pollution

877 00:36:03.444 --> 00:36:04.277 from other sources.

878 00:36:05.473 --> 00:36:07.230 We found that lower income households

879 00:36:07.230 --> 00:36:11.540 tend to face a disproportionate mortality risk burden

880 00:36:11.540 --> 00:36:13.571 from ambient air pollution.

881 00:36:13.571 --> 00:36:16.820 And this has to do with the location of point sources

882 00:36:16.820 --> 00:36:18.397 around the country

883 00:36:18.397 --> 00:36:19.870 and the distribution of populations.

884 00:36:19.870 --> 00:36:22.661 But, despite all of that,

885 00:36:22.661 --> 00:36:25.920 really clean cookstoves are an important mitigation measure

886 00:36:25.920 --> 00:36:28.223 because of the impact on indoor air pollution.

887 00:36:29.623 --> 00:36:30.456 But overall,

888 00:36:30.456 --> 00:36:32.423 I think the importance of this study

889 00:36:32.423 --> 00:36:35.320 is really to think about in the broader context,

890 00:36:35.320 --> 00:36:36.190 indoor air pollution-

891 00:36:36.190 --> 00:36:37.023 um, sorry.

892 00:36:38.229 --> 00:36:40.553 consumption as a means of mitigation of air pollution.

893 00:36:41.594 --> 00:36:42.594 There's a growing interest

894 00:36:42.594 --> 00:36:44.192 in the climate mitigation literature

895 00:36:44.192 --> 00:36:45.630 to focus more on demand side options.

896 00:36:45.630 --> 00:36:49.148 And therefore, it's important to think about the co-benefits

897 00:36:49.148 --> 00:36:51.389 from sustainable consumption as well.

898 00:36:51.389 --> 00:36:53.447 And you don't really think about that very much.

899 00:36:53.447 --> 00:36:54.723 But there's a broader theme here.

900 00:36:55.696 --> 00:36:57.326 That we tend to export pollution

901 00:36:57.326 --> 00:36:59.570 associated with our consumption in so many different ways.

902 00:36:59.570 --> 00:37:01.720 Climate change is an obvious one where we export them

903 00:37:01.720 --> 00:37:02.740 to future generations.

904 00:37:02.740 --> 00:37:06.241 And from richer countries to poorer countries.

905 00:37:06.241 --> 00:37:07.610 That's been shown by the IPCC.

906 00:37:07.610 --> 00:37:08.553 Time and again,

907 00:37:09.986 --> 00:37:10.819 we see that with waste, of course.

908 00:37:10.819 --> 00:37:13.140 We export our waste to different countries as well.

909 00:37:13.140 --> 00:37:15.688 But we're also seeing that in terms of air pollution,

910 00:37:15.688 --> 00:37:16.991 more and more,

911 00:37:16.991 --> 00:37:19.853 now across countries and within countries as well.

912 00:37:19.853 --> 00:37:22.723 And so this the main result from this study.

913 00:37:23.785 --> 00:37:24.618 And so lastly,

914 00:37:24.618 --> 00:37:26.647 I wanna point out on the methodological side.

915 00:37:26.647 --> 00:37:27.840 I think that this study is generalizable

916 00:37:27.840 --> 00:37:29.540 in terms of the approach.

917 00:37:29.540 --> 00:37:32.550 This could be applied to really any economy.

918 00:37:32.550 --> 00:37:35.130 If you have the analytical framework

919 00:37:35.130 --> 00:37:37.830 to calculate your footprints.

920 00:37:37.830 --> 00:37:39.915 And you have an air pollution model

921 00:37:39.915 --> 00:37:41.800 with an atmospheric dispersion.

922 00:37:41.800 --> 00:37:43.970 It's possible to do this kind of analysis

923 00:37:43.970 --> 00:37:46.115 and really have any context,

924 00:37:46.115 --> 00:37:47.876 just by replacing the data.

925 00:37:47.876 --> 00:37:49.095 And I think that would be something

926 00:37:49.095 --> 00:37:50.190 that would be useful to do.

927 00:37:50.190 --> 00:37:51.590 As I mentioned,

928 00:37:51.590 --> 00:37:55.105 just to think about sustainable consumption more broadly.

929 00:37:55.105 --> 00:37:56.618 So, thank you for your attention.

930 00:37:56.618 --> 00:37:58.567 And now, I will be joining you live

931 00:37:58.567 --> 00:38:00.537 in order to answer questions that you may have.

932 00:38:00.537 --> 00:38:01.954 Thanks very much.

933 00:38:02.912 --> 00:38:04.810 <v ->Thanks, Dr. Rao,</v>

934 00:38:04.810 --> 00:38:06.450 for this very wonderful talk.

935 00:38:07.767 --> 00:38:09.610 And actually,

936 00:38:09.610 --> 00:38:12.340 all your questions, Dr. Rao

937 00:38:12.340 --> 00:38:13.283 as we seen them.

938 00:38:14.458 --> 00:38:15.800 And, as you may find out.

939 00:38:15.800 --> 00:38:17.837 During his talk,

940 00:38:17.837 --> 00:38:20.319 some of your questions has been already answered.

941 00:38:20.319 --> 00:38:21.646 Like, the DTR zone,

942 00:38:21.646 --> 00:38:23.420 the pollution inequity effects,

943 00:38:23.420 --> 00:38:25.480 or whether his approach could be applied

944 00:38:25.480 --> 00:38:28.670 to other different countries or settings.

945 00:38:28.670 --> 00:38:33.670 But collectively, I think your questions

946 00:38:34.640 --> 00:38:36.340 are falling within the two things.

947 00:38:38.544 --> 00:38:42.180 We can ask Dr. Rao to answer them live.

948 00:38:42.180 --> 00:38:43.040 And in the meantime,

949 00:38:43.040 --> 00:38:44.655 for our,

950 00:38:44.655 --> 00:38:45.922 the other online audiences,

951 00:38:45.922 --> 00:38:47.853 if you do have any questions,

952 00:38:47.853 --> 00:38:50.610 please feel free to post your questions in the chat box

953 00:38:50.610 --> 00:38:54.873 and we will do the Q & A as well.

954 00:38:56.294 --> 00:38:57.127 So, Dr. Rao,

955 00:38:59.610 --> 00:39:00.910 if you,

956 00:39:00.910 --> 00:39:02.157 I see you here.

957 00:39:02.157 --> 00:39:04.563 So, if you can unmute yourself,

958 00:39:05.506 --> 00:39:09.053 then maybe we can start the Q & A section.

959 00:39:11.253 --> 00:39:12.086 <v ->Sure. Hi.</v>

960 00:39:12.086 --> 00:39:13.673 I hope you can hear me okay?

961 00:39:13.673 --> 00:39:15.107 <v ->Yeah, we hear you very well.</v> <v Dr. Rao>Great.</v>

962 00:39:15.107 --> 00:39:19.210 <v ->Thanks for joining us this way on the (indistinct)</v>

963 00:39:19.210 --> 00:39:24.073 So, I think before the whole audience can ask questions,

964 00:39:25.488 --> 00:39:28.239 we can first start with the students,

965 00:39:28.239 --> 00:39:29.700 the questions they have.

966 00:39:29.700 --> 00:39:31.033 The first type of questions,

967 00:39:32.011 --> 00:39:34.790 is generally about relationship between air pollution

968 00:39:34.790 --> 00:39:37.473 in the country and some of the detailed questions,

969 00:39:38.388 --> 00:39:39.221 for example,

970 00:39:39.221 --> 00:39:40.263 students are wondering,

971 00:39:41.239 --> 00:39:45.470 what's the link between the global versus local actions?

972 00:39:45.470 --> 00:39:47.293 And among the different countries;

973 00:39:48.239 --> 00:39:52.400 Do development rise play in a role in determining

974 00:39:52.400 --> 00:39:55.750 the inequity in the air pollution exposure.

975 00:39:55.750 --> 00:40:00.140 And also, in terms of the content of impact.

976 00:40:00.140 --> 00:40:02.660 Data that also recent COP26,

977 00:40:02.660 --> 00:40:05.510 address those issues indirectly

978 00:40:06.652 --> 00:40:08.253 or maybe completely ignore them.

979 00:40:09.349 --> 00:40:11.063 So, Dr. Rao?

980 00:40:12.652 --> 00:40:15.748 <v ->Yeah, that's a very interesting set of questions</v>

981 00:40:15.748 --> 00:40:17.230 around the link between climate change and air pollution.

982 00:40:17.230 --> 00:40:18.573 And kind of a global,

983 00:40:20.450 --> 00:40:23.589 the global imperatives versus the local imperatives

984 00:40:23.589 --> 00:40:24.533 of feeding up air pollution.

985 00:40:25.441 --> 00:40:26.274 What's interesting about the cookstoves,

986 00:40:26.274 --> 00:40:29.410 is that the biomass cookstoves

987 00:40:29.410 --> 00:40:32.891 have a lot of their own emissions;

988 00:40:32.891 --> 00:40:35.091 short-term forces that cause climate change.

989 00:40:36.092 --> 00:40:37.950 And they're extremely inefficient.

990 00:40:37.950 --> 00:40:40.788 So, when we switch over to even gas-based stoves

991 00:40:40.788 --> 00:40:42.440 or LPG stoves;

992 00:40:42.440 --> 00:40:46.840 even though gas is produced in fossil resources

993 00:40:46.840 --> 00:40:48.363 and causes CO2 emissions.

994 00:40:49.540 --> 00:40:51.699 The net effect on climate is actually almost negligible.

995 00:40:51.699 --> 00:40:53.960 Because the efficiency of gas stoves is so much higher

996 00:40:53.960 --> 00:40:57.920 and you avoid all of the other short-term climate forces.

997 00:40:57.920 --> 00:41:00.430 The net effect is almost negligible.

998 00:41:00.430 --> 00:41:01.611 So in other words,

999 00:41:01.611 --> 00:41:03.520 to switch over to LPG stoves,

1000 00:41:03.520 --> 00:41:07.260 which is currently the most popular substitute

1001 00:41:08.463 --> 00:41:09.730 is not a climate issue.

1002 00:41:09.730 --> 00:41:11.213 Which is good,

1003 00:41:11.213 --> 00:41:13.843 because people often saw that as a potential conflict.

1004 00:41:15.080 --> 00:41:16.220 If you will, to electric stoves,

1005 00:41:16.220 --> 00:41:18.220 which I do think is the long-term solution.

1006 00:41:18.220 --> 00:41:20.220 Initially in India,

1007 00:41:20.220 --> 00:41:22.260 because we have a coal dominant electric sector.

1008 00:41:22.260 --> 00:41:26.401 It would be an increase in emissions,

1009 00:41:26.401 --> 00:41:28.520 CO2 emissions in the short-term.

1010 00:41:28.520 --> 00:41:29.370 But in the long-term,

1011 00:41:29.370 --> 00:41:31.271 as you decarbonize the electric sector,

1012 00:41:31.271 --> 00:41:32.690 of course, the idea is that the electric stoves

1013 00:41:32.690 --> 00:41:34.393 will be zero carbon.

1014 00:41:35.260 --> 00:41:39.573 So, that is the immediate impact of cookstoves and climate.

1015 00:41:40.768 --> 00:41:42.870 Broadly, this topic is not really addressed so much

1016 00:41:42.870 --> 00:41:44.930 in the sort of co-benefits

1017 00:41:44.930 --> 00:41:48.430 that richer people tend to look much more at transport;

1018 00:41:48.430 --> 00:41:50.769 because that's a clear co-benefit,

1019 00:41:50.769 --> 00:41:52.630 reducing air pollution and reducing emissions

1020 00:41:52.630 --> 00:41:55.040 in decarbonizing transport.

1021 00:41:55.040 --> 00:41:57.698 So, I do think cookstoves need to be brought

1022 00:41:57.698 --> 00:41:59.296 into the equation a little bit.

1023 00:41:59.296 --> 00:42:01.790 Because there's a strong development core benefit

1024 00:42:01.790 --> 00:42:02.940 of pursuing cookstoves.

1025 00:42:03.786 --> 00:42:06.195 And potentially, a climate benefit in the long-term

1026 00:42:06.195 --> 00:42:07.183 with electric cookstoves.

1027 00:42:08.521 --> 00:42:10.130 And I don't think there has been any focus on this

1028 00:42:10.130 --> 00:42:12.275 in the negotiations.

1029 00:42:12.275 --> 00:42:14.290 We far removed from it really.

1030 00:42:14.290 --> 00:42:15.743 It doesn't really factor in.

1031 00:42:16.864 --> 00:42:18.360 But I do think,

1032 00:42:18.360 --> 00:42:20.550 a lot of the climate policy in developing countries

1033 00:42:20.550 --> 00:42:22.700 needs to be looked at as development first.

1034 00:42:23.659 --> 00:42:26.103 That is, looking at development policies entry point,

1035 00:42:26.944 --> 00:42:29.361 and doing that in a manner that's climate friendly.

1036 00:42:29.361 --> 00:42:31.000 In that kind of a conversation,

1037 00:42:31.000 --> 00:42:33.287 looking at cookstoves is really important.

1038 00:42:34.593 --> 00:42:35.426 (cricket chirping)

1039 00:42:35.426 --> 00:42:36.535 <v Facilitator>Thanks, Dr. Rao.</v>

1040 00:42:36.535 --> 00:42:38.853 The second type of question is,

1041 00:42:39.934 --> 00:42:44.290 you have shown there is very vast differences

1042 00:42:44.290 --> 00:42:45.757 in terms of the deciles

1043 00:42:48.502 --> 00:42:51.669 regarding the lowest of income (indistinct) contribute,

1044 00:42:51.669 --> 00:42:55.100 the less, but they suffer the most from the air pollution

1045 00:42:55.100 --> 00:42:56.123 related mortality.

1046 00:42:57.099 --> 00:42:59.230 And so, the students are wondering.

1047 00:42:59.230 --> 00:43:03.293 Are there any policies to effectively check the status quo?

1048 00:43:04.347 --> 00:43:06.863 So, how can we reduce this inequity?

1049 00:43:07.860 --> 00:43:09.593 Particularly, through consumption.

1050 00:43:10.776 --> 00:43:12.810 Examples, these students are wondering,

1051 00:43:12.810 --> 00:43:17.495 what are the most cost effective and last floating options

1052 00:43:17.495 --> 00:43:18.328 that work?

1053 00:43:18.328 --> 00:43:21.860 How do we incentivize the behavioral changes

1054 00:43:21.860 --> 00:43:23.113 for people to,

1055 00:43:24.026 --> 00:43:25.070 for example, you mentioned cookstoves.

1056 00:43:25.070 --> 00:43:30.070 How can we incentivize people to use more clean cookstoves

1057 00:43:31.697 --> 00:43:32.530 and a whole,

1058 00:43:32.530 --> 00:43:36.393 also you showed that for the high-income population;

1059 00:43:37.400 --> 00:43:39.320 accurately, the food and food waste

1060 00:43:40.796 --> 00:43:44.780 has the kind of the large contribution to the air pollution.

1061 00:43:44.780 --> 00:43:48.763 So, how can we reduce this urban food waste?

1062 00:43:50.053 --> 00:43:50.886 And then lastly,

1063 00:43:52.006 --> 00:43:53.805 What are the key policy challenges

1064 00:43:53.805 --> 00:43:55.928 that you could have going on?

1065 00:43:55.928 --> 00:43:58.440 Do you know whether these policy

1066 00:43:58.440 --> 00:44:01.283 has been achieved on so far?

1067 00:44:04.055 --> 00:44:04.888 <v ->Yeah.</v>

1068 00:44:04.888 --> 00:44:05.730 So, the policy or the situation,

1069 00:44:05.730 --> 00:44:07.560 as with a lot of climate issues.

1070 00:44:07.560 --> 00:44:09.920 There's a big disconnect between reality

1071 00:44:09.920 --> 00:44:13.101 and what we see in our models and analysis.

1072 00:44:13.101 --> 00:44:15.380 So, seeing air pollution as a consumption issue,

1073 00:44:15.380 --> 00:44:17.123 is very far removed from policy.

1074 00:44:18.238 --> 00:44:20.838 I think air pollution policies are focused a lot on,

1075 00:44:22.658 --> 00:44:23.491 like I said,

1076 00:44:23.491 --> 00:44:25.496 in end-of-pipe solutions.

1077 00:44:25.496 --> 00:44:28.720 And those are really still the main focus of policy.

1078 00:44:28.720 --> 00:44:30.690 Cookstoves in particular,

1079 00:44:30.690 --> 00:44:34.508 even just simply coming up with a cost-effective

1080 00:44:34.508 --> 00:44:36.650 alternatives has been very, very difficult.

1081 00:44:36.650 --> 00:44:38.173 As I mentioned in India,

1082 00:44:40.194 --> 00:44:41.060 the main substitute has been

1083 00:44:41.060 --> 00:44:43.610 LPG, liquid petroleum gas stoves.

1084 00:44:43.610 --> 00:44:45.870 And there has been a very successful experiment

1085 00:44:45.870 --> 00:44:48.650 in the last few years by the Modi government.

1086 00:44:48.650 --> 00:44:50.800 Where 15 million households

1087 00:44:50.800 --> 00:44:55.033 actually were given free cookstoves and one cylinder.

1088 00:44:56.261 --> 00:44:58.331 And that was seen as a major success,

1089 00:44:58.331 --> 00:44:59.463 especially in urban areas.

1090 00:45:00.358 --> 00:45:03.313 But, we found from research subsequent to that program,

1091 00:45:04.580 --> 00:45:08.359 that people didn't end up using the gas stove so much.

1092 00:45:08.359 --> 00:45:09.469 And the reason is that,

1093 00:45:09.469 --> 00:45:11.059 even though they got a free stove,

1094 00:45:11.059 --> 00:45:13.070 the fuel was too expensive.

1095 00:45:13.070 --> 00:45:15.270 And the fuel has not been subsidized enough.

1096 00:45:16.280 --> 00:45:17.961 In fact, the prices have been liberalized

1097 00:45:17.961 --> 00:45:19.090 over the last decade.

1098 00:45:19.090 --> 00:45:20.863 So, that's the problem.

1099 00:45:21.751 --> 00:45:24.700 We need to subsidize both the fuel and the stove.

1100 00:45:24.700 --> 00:45:28.173 If you really want a sustained shift over to other fuels.

1101 00:45:29.120 --> 00:45:32.150 Because people may be familiar that people stack stoves,

1102 00:45:32.150 --> 00:45:33.450 they have multiple stoves;

1103 00:45:34.572 --> 00:45:36.319 and they use the one that's cheapest.

1104 00:45:36.319 --> 00:45:39.453 So, the policy solutions are not successful yet.

1105 00:45:40.938 --> 00:45:42.253 Let alone, look at consumption.

1106 00:45:43.707 --> 00:45:44.540 In the area of consumption,

1107 00:45:44.540 --> 00:45:47.130 I think behavioral change to reduce consumption;

1108 00:45:47.130 --> 00:45:49.930 I mean, we can think about that as being extremely difficult

1109 00:45:49.930 --> 00:45:50.973 in any context.

1110 00:45:52.198 --> 00:45:53.908 What's more important maybe from the study,

1111 00:45:53.908 --> 00:45:55.630 is to focus on food and food waste

1112 00:45:55.630 --> 00:45:56.933 as an air pollution issue.

1113 00:45:57.968 --> 00:46:00.199 Which is not often viewed that way.

1114 00:46:00.199 --> 00:46:01.910 So, thinking about cleaning up waste;

1115 00:46:01.910 --> 00:46:03.373 not only for recycling,

1116 00:46:04.276 --> 00:46:06.340 but to control how it's disposed off

1117 00:46:06.340 --> 00:46:08.338 and to prevent its burning,

1118 00:46:08.338 --> 00:46:10.146 or doing controlled burning.

1119 00:46:10.146 --> 00:46:13.060 Having incineration in an organized manner in cities,

1120 00:46:13.060 --> 00:46:16.027 where they have controls for pollution.

1121 00:46:16.027 --> 00:46:19.064 That, I think is probably the insight that's most important

1122 00:46:19.064 --> 00:46:21.664 from this study with regards to policy more broadly.

1123 00:46:24.750 --> 00:46:26.430 <v Facilitator>Thanks Dr. Rao for sharing that insight</v>

1124 00:46:26.430 --> 00:46:28.025 and expanding.

1125 00:46:28.025 --> 00:46:29.803 We do have a few minutes left at that.

1126 00:46:31.094 --> 00:46:32.064 Any of our,

1127 00:46:32.064 --> 00:46:33.940 also online audience want to ask a question,

1128 00:46:33.940 --> 00:46:36.980 please feel free to post the question on the chat box.

1129 00:46:36.980 --> 00:46:40.123 Or if you want to ask directly,

1130 00:46:41.036 --> 00:46:42.273 feel free to unmute yourself.

1131 00:46:44.451 --> 00:46:45.551 And before we move on,

1132 00:46:47.502 --> 00:46:51.823 I even had another question regarding this type of research

1133 00:46:52.682 --> 00:46:54.433 that Dr. Rao,

1134 00:46:54.433 --> 00:46:58.867 you showed us that the very drastic differences

1135 00:47:00.290 --> 00:47:03.550 in the low-income country,

1136 00:47:03.550 --> 00:47:06.100 low-income communities versus the high-income communities

1137 00:47:06.100 --> 00:47:07.403 in terms of the inequity.

1138 00:47:09.124 --> 00:47:14.124 So, this type of Pollution Equity Index.

1139 00:47:15.916 --> 00:47:19.634 You mentioned that it can be applied to different countries.

1140 00:47:19.634 --> 00:47:20.923 So, I'm particularly wondering,

1141 00:47:20.923 --> 00:47:23.674 that do you have any plans for future work,

1142 00:47:23.674 --> 00:47:27.120 like, focusing on not just India but in the United States?

1143 00:47:27.120 --> 00:47:27.953 Because, one,

1144 00:47:29.834 --> 00:47:31.910 the recent researchers found that,

1145 00:47:31.910 --> 00:47:36.910 actually the food production consumption also contributes,

1146 00:47:39.230 --> 00:47:42.403 is also a major contribution to the ambient air pollution

1147 00:47:42.403 --> 00:47:44.500 due to the house impacts in the United States as well.

1148 00:47:44.500 --> 00:47:46.103 So, I'm thinking about,

1149 00:47:46.984 --> 00:47:50.563 if you can apply this Pollution Equity Index

1150 00:47:50.563 --> 00:47:52.002 to the United States,

1151 00:47:52.002 --> 00:47:57.002 what could be some of the major messages that you can wave

1152 00:47:58.025 --> 00:47:58.925 for policy makers?

1153 00:47:59.820 --> 00:48:02.723 <v ->Yeah, actually there is a research group.</v>

1154 00:48:04.354 --> 00:48:05.187 I had mentioned it,

1155 00:48:05.187 --> 00:48:06.020 I think in part of this talk.

1156 00:48:06.020 --> 00:48:08.403 A Tesa metal paper, it's in Phoenix.

1157 00:48:09.957 --> 00:48:11.247 I believe Phoenix,

1158 00:48:11.247 --> 00:48:12.980 where they have done a very nice study

1159 00:48:14.058 --> 00:48:16.650 that does this relationship between consumption

1160 00:48:16.650 --> 00:48:17.783 and air pollution.

1161 00:48:18.997 --> 00:48:21.030 And so, we do have research groups

1162 00:48:21.991 --> 00:48:23.340 and the data are available in the U.S.

1163 00:48:24.308 --> 00:48:25.141 to do this analysis.

1164 00:48:25.141 --> 00:48:26.290 The missing piece there,

1165 00:48:26.290 --> 00:48:29.100 in that study was to take exposures

1166 00:48:29.100 --> 00:48:31.197 at a especially granular level

1167 00:48:31.197 --> 00:48:33.597 and convert that into mortality risk.

1168 00:48:33.597 --> 00:48:34.910 So, that's the part that we'd need to be done.

1169 00:48:34.910 --> 00:48:37.588 And then, one can look at pollution equity,

1170 00:48:37.588 --> 00:48:40.730 not just in terms of exposure and consumption comparisons;

1171 00:48:40.730 --> 00:48:43.160 But mortality consumption.

1172 00:48:43.160 --> 00:48:45.460 And I think that would be a useful step to do.

1173 00:48:47.376 --> 00:48:50.460 I don't personally, have access to those data.

1174 00:48:50.460 --> 00:48:51.570 I'm on energy side.

1175 00:48:51.570 --> 00:48:54.404 I am working in fact,

1176 00:48:54.404 --> 00:48:55.913 on residential energy in the U.S.

1177 00:48:56.772 --> 00:48:58.472 at a detailed spatial granularity,

1178 00:48:59.524 --> 00:49:01.184 with spatial granularity.

1179 00:49:01.184 --> 00:49:02.220 And it would be an opportunity to team up

1180 00:49:02.220 --> 00:49:04.050 with air pollution folks to...

1181 00:49:06.159 --> 00:49:07.513 Kyle is an example of it himself.

1182 00:49:07.513 --> 00:49:08.346 (chuckles)

1183 00:49:08.346 --> 00:49:10.930 To look at that kind of inequity

1184 00:49:10.930 --> 00:49:14.100 or looking at mortality risks for specific communities

1185 00:49:14.100 --> 00:49:16.260 and comparing it to consumption levels.

1186 00:49:16.260 --> 00:49:19.669 And I think that is certainly something that's worth doing,

1187 00:49:19.669 --> 00:49:23.362 and possible for us to collaborate and do in the future.

1188 00:49:23.362 --> 00:49:24.195 <v Facilitator>Excellent, yeah.</v>

1189 00:49:24.195 --> 00:49:27.528 I think that'll be a very emerging field

1190 00:49:29.002 --> 00:49:32.010 for a lot of researchers like you.

1191 00:49:32.010 --> 00:49:34.343 Working in handy site for researchers

1192 00:49:34.343 --> 00:49:35.910 in the air pollution field

1193 00:49:35.910 --> 00:49:38.670 and for our students and all our audiences working

1194 00:49:38.670 --> 00:49:41.310 maybe in the environment of agricultural food.

1195 00:49:41.310 --> 00:49:43.380 So, thank you, Dr. Rao.

1196 00:49:43.380 --> 00:49:45.163 I don't see there's,

1197 00:49:46.770 --> 00:49:48.183 but there's one question.

1198 00:49:50.555 --> 00:49:52.698 <v ->I see one more question in the chat.</v>

1199 00:49:52.698 --> 00:49:53.531 <v Facilitator>Yes.</v>

1200 00:49:53.531 --> 00:49:55.703 Okay, Richter Autry. <v ->Yeah.</v>

1201 00:49:56.837 --> 00:49:57.670 <v Facilitator>So, Richter Autry;</v>

1202 00:49:57.670 --> 00:50:00.350 Do you think it would be more efficient to enrol

1203 00:50:00.350 --> 00:50:03.860 with the private sector in bringing about a faster

1204 00:50:03.860 --> 00:50:05.160 and more efficient change?

1205 00:50:08.106 --> 00:50:08.939 <v ->Mm.</v>

1206 00:50:10.064 --> 00:50:11.553 Um...

1207 00:50:11.553 --> 00:50:14.110 I think the private sector will be undoubtedly necessary

1208 00:50:14.110 --> 00:50:15.370 for the implementation of these policies.

1209 00:50:15.370 --> 00:50:18.356 They will be the provider of these technologies,

1210 00:50:18.356 --> 00:50:19.189 for sure.

1211 00:50:19.189 --> 00:50:21.767 I think, it also would require

1212 00:50:21.767 --> 00:50:26.133 as much government regulation as well to guide investments.

1213 00:50:27.211 --> 00:50:28.376 I think for example,

1214 00:50:28.376 --> 00:50:32.053 with norms for automobiles standards.

1215 00:50:33.510 --> 00:50:36.403 Those are generally regulated wherever you go.

1216 00:50:38.054 --> 00:50:39.500 It's something that has to be regulated

1217 00:50:39.500 --> 00:50:40.493 'cause there's not much incentive.

1218 00:50:42.694 --> 00:50:44.089 There's no private benefit associated

1219 00:50:44.089 --> 00:50:45.839 with the air pollution reduction.

1220 00:50:45.839 --> 00:50:47.613 And so, it has to be guided by policy.

1221 00:50:48.933 --> 00:50:49.766 But I think,

1222 00:50:49.766 --> 00:50:51.295 there could be,

1223 00:50:51.295 --> 00:50:52.610 it has to be asked whether there's enough incentive

1224 00:50:52.610 --> 00:50:55.787 for the providers of those technologies

1225 00:50:55.787 --> 00:50:57.836 to enter the market for them.

1226 00:50:57.836 --> 00:50:59.000 So, that definitely is an issue.

1227 00:50:59.000 --> 00:51:02.219 I think with cookstoves,

1228 00:51:02.219 --> 00:51:03.955 it's not necessarily an issue.

1229 00:51:03.955 --> 00:51:05.560 There's plenty of market incentive to provide,

1230 00:51:05.560 --> 00:51:06.683 to sell these stoves.

1231 00:51:07.755 --> 00:51:10.167 The government has to just subsidize them.

1232 00:51:10.167 --> 00:51:11.749 Make them affordable.

1233 00:51:11.749 --> 00:51:13.423 And for other end-of-pipe solutions;

1234 00:51:15.452 --> 00:51:16.285 cleaning up waste, for example.

1235 00:51:16.285 --> 00:51:18.327 that is another externality.

1236 00:51:18.327 --> 00:51:22.547 It's hard to see just the private sector leading that.

1237 00:51:22.547 --> 00:51:24.355 But I do think they have to be involved

1238 00:51:24.355 --> 00:51:26.010 in terms of providing the technologies.

1239 00:51:26.010 --> 00:51:28.716 But, I think regulation is really the answer

1240 00:51:28.716 --> 00:51:30.833 in terms of making a shift today.

1241 00:51:33.996 --> 00:51:34.829 <v Facilitator>Thank you, Dr. Rao.</v>

1242 00:51:34.829 --> 00:51:39.600 Yes, I think this speaks to the very core

1243 00:51:39.600 --> 00:51:44.600 of what the purpose of the caption the house constitution,

1244 00:51:46.354 --> 00:51:49.684 is to train the next generation of leaders

1245 00:51:49.684 --> 00:51:51.370 who might be the policy makers

1246 00:51:51.370 --> 00:51:53.285 than to have us tackle on this issue.

1247 00:51:53.285 --> 00:51:55.702 So, thank you for Vanessa.

1248 00:51:55.702 --> 00:51:58.002 And thank you so much for answering the Q & A.

1249 00:51:58.915 --> 00:52:01.114 I don't think there'll be other questions.

1250 00:52:01.114 --> 00:52:03.254 And so, maybe we can check out.

1251 00:52:03.254 --> 00:52:04.350 We can have five minutes earlier.

1252 00:52:04.350 --> 00:52:06.203 And thank you all for joining us,

1253 00:52:07.106 --> 00:52:08.595 in person and online.

1254 00:52:08.595 --> 00:52:09.483 Thank you.

1255 00:52:09.483 --> 00:52:12.755 I think we can give a round of applause for Dr. Rao.

1256 00:52:12.755 --> 00:52:16.470 <v ->Thank you so much for tolerating this suboptimal</v>

1257 00:52:16.470 --> 00:52:17.460 form of communication,

1258 00:52:17.460 --> 00:52:18.883 but I appreciate it.

1259 00:52:19.734 --> 00:52:20.813 Bye-bye.

1260 00:52:20.813 --> 00:52:21.995 (indistinct)