Judith Kelley: Hello and welcome to Policy 360. I'm Judith Kelley, Dean of the Sanford School of Public Policy at Duke University. I have three Duke students with me today who have spent the last year working on energy access in Zambia. According to USAID, national access to electricity in Zambia is at 31% and only 4% of the rural population has access to power. As part of an interdisciplinary team called Bass Connections, students are trying to get a better understanding of the barriers to energy investment there, especially the off the grid electricity market. The faculty and the staff of the energy access project at Duke who have expertise in areas like economics and data analytics and power systems, led the teams. Seven Duke undergrads and five master's students participated and many of the students traveled to Zambia. Because it's an interdisciplinary team, the project includes both policy analysis and a pretty cool web app as well. Aashna Aggarwal is a team member. Aashna is graduating this year with a degree in economics. She also completed Sanford Summer Global Policy Program in Geneva. Welcome Aashna.

Aashna Aggarwal: Thank you.

Judith Kelley: Miranda Wolford is a sophomore majoring in Political Science and in International Comparative Studies. Welcome Miranda.

Miranda Wolford: Thank you so much.

Judith Kelley: Sumin Wang is also here. Sumin is a Master students studying Environmental Management Energy and the Environment. Welcome Sumin.

Sumin Wang: Thank you. Pleasure to be here.

Judith Kelley: First, we'll start with you Aashna. So, describe the big picture for us. Why Zambia?

Aashna Aggarwal: So, the class is called From the Ground Up and we wanted to study a country from the way roots to high level functions in the energy industry over there. And the professors of this course were looking at different countries in sub-Saharan African region to begin with. And Zambia seems like a very interesting case, because not a lot of work and energy has been done there before as compared to some other countries. And also it has a pretty stable political environment for us to indulge in and make connections with partner organizations.

Judith Kelley: So, before we get into the nitty gritty of the project, give us a snapshot of one of the communities that you visited. So, what was it like? So, the housing, of roads, the countryside, that sort of thing.

Aashna Aggarwal: So, we visited a couple of communities in Zambia and a lot of these were rural communities, but along the rail and the roadways, so still pretty much connected to urban civilization. One of these communities we went to was

Monze, where we got to talk to a couple of households that were either connected to grid electricity or use solar panels. And we got a lot of interesting things from these communities, because we wanted to really understand how demand looks like there. What are the desires and aspirations of these households when they try to buy energy services or energy products in the future? So, all the households had different construction material used. There were some that were constructed with brick, there were some that were constructed with wood and there were a lot of different variations in the households we came across. Some of the people we interviewed, we went to their house, whereas some people we interviewed, we went to their workplace and saw if they were using any electrical devices or refrigerators or things like that, in a shop they managed or like a restaurant they ran.

Judith Kelley: Right. So, you were on what's called the willingness to pay team?

Aashna Aggarwal: Yeah, that's correct.

Judith Kelley: What does that mean? Explain that to us, willingness to pay.

Aashna Aggarwal: Sure. So, willingness to pay is basically a metric to understand demand and how much are consumers actually willing to pay for services? So, we wanted to get a geospatial understanding and map that across Zambia and see which are the most lucrative markets for off grid developers to be in.

Judith Kelley: Excellent. So, you also adapted methods from different studies that looked at the willingness to pay for high capacity sort of systems in Rwanda, for example. So, can you give me a synopsis of that? What kind of information did you have? How did that work?

Aashna Aggarwal: Sure. So, we first studied what literature exists out there in terms of willingness to pay studies, and we found out that currently there's not a lot of work that's been done in this particular area, but one author, he's an economist named Grim, with his colleagues, conducted a small experimental study in Rwanda. And we reached out to them and they were kind enough to share their microdata with us. So, we analyzed this data that we got from Rwanda where they basically conducted an experiment to see how much are people actually willing to pay in reality for these solar products. And then we try to study the relationship between different demographic and socioeconomic factors of Rwanda with their willingness to pay. And then we did something that's called a benefits transfer study and transferred those demographic and socioeconomic factors to Zambia and studied the relationship between those in the Zambian context. That helped us do a statistical econometric analysis to calculate the willingness to pay for Zambian districts and communities there.

Judith Kelley: And were you surprised by their willingness to pay level? Was it more or less than you expected or?

Aashna Aggarwal: Yeah, it's pretty weighed across different places. There are definitely shortcomings to this study and it's not the most perfect study. So, trying to say if it's ... I didn't go in with any sort of pre-notions of what I would see in this willingness to pay study, but it's definitely a start and we converted all our currency to United States dollars. So, it was a little different to see what their willingness to pay would be in their national currency, which is the Zambian Kwacha.

Judith Kelley: I see. Okay. Well Miranda, let's talk a little bit with you. So, you were on the policy team.

Miranda Wolford: Yes.

Judith Kelley: So, what was the goal of that team?

Miranda Wolford: Well the goal was, as Aashna mentioned earlier, the energy landscape in Zambia has been relatively untapped in comparison to neighboring countries, in countries like Kenya where they have a thriving off grid energy private sector. And so we were meeting with all of these private sector companies, government agencies, NGO's, and we really wanted to create a sort of document or resource for private companies looking to enter the space and also financers and backers looking to enter the space, to connect sort of all of the dots that we met with and create that sort of market overview and market landscape that highlighted both the opportunities in the space, the immense untapped market. And then also the many challenges that come with this space, such as the unpredictability, being that it's such a new space for private companies to expand into, there's a lot of reactionary policy.

So, a company will go in, have some innovation in their technology or their business model, and then oftentimes you see the Zambian government or the policy bodies struggling to catch up with in terms of policy creation. So, trying to outline and relay that as one of the challenges facing private companies. So, really just to give them a big market overview and a document that's both accessible and aesthetic for foreign companies, but also highly emphasizing that there needs to be a greater capacity and emphasis placed on local talent and local companies as well.

Judith Kelley: Was it difficult to map all those relationships out? Did you find anything in pricing?

Miranda Wolford: Yeah. I mean, believe it or not in, I was fortunate enough to be on the team that went to Zambia way back in August and I thought it was going to be this long, endless list of people we had to meet with, but what ended up happening in our meetings was we would meet with one solar company and they'd be like, oh, you know who you should speak with? You should speak with so and so at the other one. Here, let me connect you. And so this funny thing ended up happening where by the time we were done, we met with over 40 people

representing all these private companies, organizations, whatever it may be, and had a pretty solid understanding of the space in its entirety.

Judith Kelley: Right.

Miranda Wolford: Borrowing any brand new players. So, we are able to mark out, to lay out with pretty certainty just who the players are and get a comprehensive understanding of who's actually on the ground and who's just entering the space.

Judith Kelley: What surprised you most of what you found or what experience you had?

Miranda Wolford: Yeah, what experience I had? What surprised me the most was just with all of the funding coming in and just a new emphasis on sustainability and energy access as well, that same emphasis on sustainability hasn't necessarily been extended to the actual business side of the energy access equation. So, when you're looking at local companies that often start off as individually run operations, where they're just perhaps reselling solar home products or solar home systems on the streets, those don't have the same access to early seed capital or early financing as foreign or expat owned companies. So, just really trying to get that sector of the energy access equation off the ground and just realizing that a lot of the money hadn't previously gone to those same people. That was probably was most surprising to me considering just all of the wonderful Zambian entrepreneurs we had the immense pleasure of meeting.

Judith Kelley: So is solar really the off grid option in Zambia? In some ways it sounds kind of crazy, because we're looking at an economy that ... Where few people are particularly well endowed and solar seems like a very advanced technology. Is that sort of the leap frogging that's happening there and how accessible is it for people?

Miranda Wolford: Yeah. I mean, solar is pretty much looked at as the alternative to the grid, even in urban settings like Lusaka, the capital, we would see people and wealthier families having solar home systems and solar products simply because the grid just isn't as reliable. So, if there's a power outage, they wanted to have backup power and that backup power, what we saw, nine out of 10 times was solar.

Judith Kelley: Right.

Miranda Wolford: But then you'd still see coal on the streets and there is certain sectors of the energy used in Zambia that still remains with coal and diesel.

Judith Kelley: So, it's really use of solar to power your own residents or your own needs? It's not like United States, you put solar on your house? Usually that's gonna get sold to the electricity company and then you get reimbursed somehow or whatever, right? But this is self-contained.

Miranda Wolford: Yeah.

Judith Kelley: Assuming that's a good time to transition to you.

Sumin Wang: Okay.

Judith Kelley: So, you were on the geospatial team. So, for those of us who don't know what that is, what does geospatial mean?

Sumin Wang: So, geospatial is just basically means any data that's related to locations. Think of as a map, when you look at the map you want to, you have the location of the school and each school has coordinates.

Judith Kelley: Right.

Sumin Wang: And in order to pinpoint where those schools are, you can just program it in a geospatial data and then be able to visualize it.

Judith Kelley: So, what kind of information were you trying to gather?

Sumin Wang: So, to give you a little bit background for why we decided to approach with a geospatial analysis is because when we went to Zambia in August, we interviewed some of the off grid companies, primary the microcap companies.

Judith Kelley: Yeah.

Sumin Wang: And then they told us that they have some difficulties to find locations, potential markets they can go into, because the population density in Zambia is really low. With low population density you have low demand for electricity, which is very hard for those microgrids to realize profitability.

Judith Kelley: Sure.

Sumin Wang: So, we also had an interview with USAID Southern Africa Program and then they collaborated with McKinsey to develop a geospatial model for the Zambian government. And they have a lot of really good geospatial data underlying that model. So, we were thinking that if we can collaborate with them and then get some of the data out from their model and help the microcompanies to develop an application to facilitate the process of identify potential markets, that would be great.

Sumin Wang: So, some of the data we have to help for the site selection is the locations of the health clinics, because we see health clinics as anchor customers who can pay the electricity bill more frequently, which can guarantee the profitability. And then we also look at what's the population density of the, of different area in Zambia. How accessible those communities to row, so you can transport equipment to the sites. And also how far they are away from distribution lines,

transmission lines and substations, because for those off grid developers, they actually want to try to avoid where places that has access to electricity on the grid, because they want to avoid competition.

Judith Kelley: So, who collected all this data? Your team collected it at all?

Sumin Wang: Yeah. So, a lot of those datas, they're public available. Some of them are gathered by the World Bank or other ...

Judith Kelley: So, you weren't out there walking about going, look, health clinic?

Sumin Wang: No. No. We don't have ...

Judith Kelley: Someone take the coordinates, please.

Sumin Wang: No. We don't have that capacity unfortunately, but in the future, in order to improve the data quality of this application definitely something should be done on the ground that ... To have some people to ground choose all the data we have.

Judith Kelley: So, you mentioned the application. So, tell me about that. So, you created an application.

Sumin Wang: Yes.

Judith Kelley: And can you show me how that works?

Sumin Wang: Yes. So, this application is created on a software called ArcGIS Pro. It's a software usually used to do geospatial analysis.

Judith Kelley: Sure.

Sumin Wang: And then it's uploaded on a platform called ArcGIS Online. So, this platform can allow, it's a more interactive interface that can allow people who are not familiar with GIS or ArcGIS Pro to play around data we have, the geospatial data. Basically, and also you can think of it, imagine it as like a Word document, but then you can also upload it as a Google Doc, so you can share that with people and everyone can get access to it. So, this application you can ... When you go into the application, the first thing you see is the gray areas of the ward, which is the same idea as counting the U.S. And then also the ward points are the settlements.

Judith Kelley: Right.

Sumin Wang: So, basically you can do selection of ... Based on either ward or settlement. For example, if you want to say I want that the ward has 100% cell phone coverage and then I want to have two health clinics in that ward and ... At least two

health clinics, and then I want to have three settlements and then I want the population density to to be at least 20 people per kilometers. And then after you input those criteria ...

Judith Kelley: Right.

Sumin Wang: You just click apply and this application will show you exactly whether there is a ward that meets that criteria or not. And you can do the same selection for the settlements.

Judith Kelley: Right.

Sumin Wang: And also there are layers inside this application, actually shows you where the electrify area are in Zambia. And then also it's not, it's very tiny right now. You probably cannot see, but also where the distribution lines are distributed.

Judith Kelley: So, microgrid developers can then use this to identify?

Sumin Wang: Yeah, basically ...

Judith Kelley: Potential markets.

Sumin Wang: Potential markets to go to.

Judith Kelley: Right. And you say it's an app, like is it on the phone or is it just on the computer?

Sumin Wang: It works well on a computer, but also you can pull it up on your phone, however we do have some stakeholders on the ground that have some difficulties to pull up, because the link sometimes doesn't work really well on their cell phone services.

Judith Kelley: Do you think that what you learned can sort of be exported to other countries who are dealing with the same issues?

Sumin Wang: Yes, of course. Actually.

Judith Kelley: Yeah.

Sumin Wang: Yeah. As long as you have any sort of those datas and you can transfer this methodology to develop any application for any other country.

Judith Kelley: So, what have you learned, the three of you now, what have you learned about promoting energy access in hard to reach access areas as a result of being part of this project? Aashna, why don't you start first?

Aashna Aggarwal: Sure. When we talk about energy access, a lot of times people assume that these communities do need access to electricity, but we did not realize that they have been living without access to electricity since they were born and now it doesn't really make huge difference in their lives, whereas there are instances where the quality of life could be improved and there could be economic gains if these communities get access to electricity, but it's really important to work with the communities and not just for them. So, our visits to these communities, the four committees that I mentioned before, really showed us what are the desires of these community members and do they want electricity or not? What kind of services do they want, because a lot of times energy access is not just a great connection to your house, but are you actually using the lighting or the heating or the cooking? What are you using this electricity for? Do you have a restaurant and you only need a refrigerator to cool your cold drinks or do you actually need a cookstove that is electrified to cook food for others? So, I think there are a lot of factors that go into the decision making. They're often overlooked in the equation where we're calculating energy access, but working close together with these communities is a really big part of it.

Miranda Wolford: I would agree with what Aashna said. Before taking this course, I had little to no background in the energy access and looking at it on the ground, so for me demand was just an assumption I made that people of course, who wouldn't want electricity? But then going into the communities in August, we were able to see there are some people who don't want it and then there's some people who actually will put it to productive use. I remember we were at a micro grid and we were doing a site visit and looking at how a microgrid had transformed some of the economic aspects of community. And we went in, met with this one guy who ... Stephan, who was selling drinks out of a refrigerator and had become sort of a community staple of sorts, just because he was able to capitalize on his new electricity via refrigeration and refrigerators for cold drinks that he was able to then sell to his community members.

Judith Kelley: So much better than hot drinks.

Miranda Wolford: Yeah. So much better than hot drinks. It was hot in Zambia.

Judith Kelley: Yeah.

Miranda Wolford: So, that's just like one instance of where were able to see on the ground the impact that electrification can have when it's done in partnership, as Aashna was saying, with the community at hand.

Judith Kelley: Yeah. That's excellent. And Sumin, what about you?

Sumin Wang: Yeah. For me, I think the biggest lesson learned is that to actually to make an impact, especially to solve those energy access issues, actually requires a lot of dedication and time to really think through the process. And then it's challenging too, a lot of times we think of, yes, this is a problem we just jump at

to solve it, but at the same time when you're on the ground, you realize there are a lot of social issues you need to consider, culture aspect of it and also there are stakeholders that you really need to engage with.

Sumin Wang: At first we thought we just create this application and it's for sure gonna help people on the ground, but after you develop it, you realize that you need to communicate a lot with the people who are actually gonna use this tool to bring that to an actual impact on the ground.

Judith Kelley: Is there any plan to bring the data that you collected, Aashna, about willingness to pay into your app?

Aashna Aggarwal: That's actually already there.

Sumin Wang: So, that's actually inside this application.

Judith Kelley: It's already there?

Aashna Aggarwal: Yeah.

Sumin Wang: Yes. Yes.

Judith Kelley: So.

Sumin Wang: So, you can select the ward based on the minimum willingness to pay.

Judith Kelley: Yeah.

Sumin Wang: I didn't mention that, but yeah.

Judith Kelley: That seems like it would be very helpful.

Aashna Aggarwal: Yeah. That's the only layer that our class as a team calculated, whereas the other data in the app was gathered from sources that already exist.

Judith Kelley: Right. So, this really an original contribution?

Miranda Wolford: And you'll notice all three of our deliverables work really well hand in hand together and capitalize off of the strengths of the team we came in with.

Judith Kelley: Sure.

Miranda Wolford: And then also, as Sumin mentioned, meeting with stakeholders and seeing where we could actually add value versus just learn and benefit ourselves from being a part of such a unique research team.

Judith Kelley: So, presumably none of you have been to Zambia before and now you're been, one favorite thing about Zambia?

Miranda Wolford: Oh my goodness. We had the great pleasure, way back in August, of actually ... We're coming back from the site visit at the microgrid I just mentioned, and all of a sudden our driver just stops the car and we're kind of like, what's going on?

Judith Kelley: Yeah.

Miranda Wolford: And then we see elephants just right there, maybe less than a hundred yards away, and we're not even ... We have no idea where we are. We're just, what, four hours from the capital city of Lusaka and all of a sudden we are just having to stop for traffic in the form of elephants, which for me was just absolutely wild. And you see just these really rich communities and they're having to battle elephants as their main sort of threats in the area besides other humans. So, that was really cool to see.

Judith Kelley: Yeah. Oh, that sounds like a wonderful experience. So, thank you all so very much for joining me today. It's been a pleasure hearing about your project.

Miranda Wolford: Thank you so much for having us.

Aashna Aggarwal: Thank you.

Sumin Wang: Thank you.

Judith Kelley: Aashna Aggarwall and Miranda Wolford and Sumin Wang are all students at Duke University. Bass Connections was named in honor of founding donors Anne T. and Robert M. Bass. It's one of the many gems of Duke University. And the energy access project is an exciting new initiative at Duke, the developing solutions to energy policy and market challenges and emerging economies around the world. We'll have a link to more information on our website policy360.org. I hope that you'll also check out our sister podcast, Ways and Means, which is also produced here at Sanford. One of their recent episodes follows the Sanford School Team as they trek high in the Himalayas in Nepal. I clearly picked the wrong thing of being Dean. I really should be a student again. That team is looking at why the promising green technology of tapping mountain streams for power sometimes works and sometimes doesn't in Nepal. So, that's the Ways and Means podcast. You can find it wherever you get your podcasts. Thanks for joining me today. I'm Judith Kelley.