

### Webinar Presenter

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### This Transcript

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Sean Esterly

Hello, everyone. I'm Sean Esterly with National Renewable Energy Laboratory and welcome to today's webinar hosted by the Clean Energy Solutions Center. We're both very fortunate that Caley Johnson joining us to discuss issues and possible solutions for the development of clean transportation systems and programs.

One important note of mention before we begin our presentation is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center's resource library as one of many best practices resources reviewed and selected by technical experts.

Now, I'd just let you go over some of the webinar features for this presentation. For audio, you have two options. You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the 'mic and speakers' options in the audio pane. By doing that, you will eliminate the possibility of feedback and echo. If you select the telephone option, the box on the right side will display the telephone number and audio pin you should use to dial in. Panelists, we have that if you please mute your audio device while you are not presenting. If you have any technical difficulties for the webinar, you may contact the GoToWebinar's Help Desk at 888.259.3826.

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Now, we have a great agenda prepared for you today that is focused on the Development Impact Assessment in the Transport Sector. Before Caley begin his presentation, I will provide a short informative overview of the

Clean Energy Solutions Center Initiative, and then following the presentation, we will have a question and answer session, and then wrap up with any closing remark and a brief survey.

Now, this is slide provide that instead of background in terms of how the Solutions Center came to me. Solutions Center is an initiative of the Clean Energy Ministerial and is supported to a partnership with UN-Energy. It was launched in April 2011, and then primarily led by Australia, the United State, and other CEM partners. Outcomes of this unique partnership include support of developing countries to enhancement of resources on policies to relating to energy access, at no cost expert policy assistance, and peer-to-peer learning and training tools such as this webinar.

Now, there are four primary goals for the Solutions Center. It serves as a clearinghouse of Clean Energy Policy Resources. It also serves to share policy best practices, data, and analysis tools specifically the clean energy policies and programs. Third, the Solutions Center delivers dynamic services that enable expert assistance, learning, and peer to peer sharing of experiences, and lastly, the Center fosters dialogue on emerging policy issues and innovation around the globe. Our primary audience is energy policy makers and analysts from government and technical organization in all countries, but then we also try to engage with the public—private sector, NGOs, and civil society.

One of the remarking features that the Solutions Center provides is the Expert Policy Assistance, which is known as ‘Ask an expert’, and it’s a great service offered to the Solutions Center at no cost. We’ve established a broad team of over thirty experts from around the globe who are available to provide remote policy advice and analysis to all countries. In the area of transport, we are very pleased to have Jane Wilkinson, associate director of the Venice Office Climate Policy Initiatives, and also Ted Sears who’s a senior project leader at the U.S. National Renewable Energy Laboratory, and both of those survived our transport experts.

If you have a need for policy assistance on sustainable transportation or any other clean energy sector, we encourage you to use that useful service. Again, it’s free of charge and to request assistance, you can submit your requests by registering to our ‘Ask an Expert’ feature at [cleanenergysolution.org/expert](http://cleanenergysolution.org/expert). We also invite you to spread the work about this service to those in your networks and organizations. So, we encourage everyone to explore and take advantage of the Solutions Center resources and services including that expert policy assistance, subscribe to our newsletter for updates and participate in webinars.

Now, I’d like to just provide a brief introduction to our distinguished panelist tonight. Caley Johnson is a transportation market analyst at the U.S. National Renewable Energy Laboratory. Today, Caley will be discussing tools and methodologies for identifying and evaluating impact

of implementing sustainable transport system and how performing assessment of the impact can contribute to achieving transport and development role. Caley, welcome to webinar.

- Caley Johnson Thanks, Sean. All right, so you should be able to see my screen now. I'll put on full screen mode. All right, this—can you see this letter alright, Sean? I'll take that a yes but I'm muted.
- Sean Esterly It's not showing up right now, Caley. It's just a black screen.
- Caley Johnson Okay. So I clicked, show my screen, and then I...
- Sean Esterly And you have the slide hold up on your screen?
- Caley Johnson Yeah, I do. Okay. I'll try to clean now. How about now?
- Sean Esterly Let's give it one second. There's usually second to light.
- Caley Johnson All right. I can try it in PDF if—or I can try them PowerPoint if this PDF doesn't work all right.
- Sean Esterly Yeah. It's not coming up, Caley. Another option is Heather can just run your slides for you?
- Caley Johnson Okay. Well, let me try just showing the presentation instead of showing my screen. Any luck with that one?
- Sean Esterly And now it's just a blue screen, Caley.
- Caley Johnson Uh-mm. Strange. Heather, can you try sending me the invitation again? Even though it says, 'show my screen on this.' Okay.
- Sean Esterly Caley, under 'Screen Sharing', do you see the 'Play' button?
- Caley Johnson Sorry, the what button?
- Sean Esterly There should be a 'Play' button. Make sure it's on 'Play' and not 'Pause'.
- Caley Johnson Oh. Okay. All right, I think that is the problem. Okay. There we go. Now, I hit play. Can you see it now?
- Sean Esterly No, we cannot. I think we just need to go with Heather showing your slides, Caley.
- Caley Johnson Okay, all right. Alright, so we'll start with the agenda slide number two, Heather. So today, I want to cover the Introduction to Development Impact Assessments, which I'll refer to as DIA for transportation projects. Development Impact Assessments are bit more—a bit better developed for projects other than transportation projects, and so like the carry over a lot the methodologies and kind of reframe it in the transportation world. The impacts most commonly assessed in DIAs, I'll cover that. I'll cover why

they're assessed. How they're assessed? What techniques, guides, and tools are used for this assessment? And then talk a little bit about the difficulties to assessing transportation projects. How to prioritize between impacts? And which includes specific goals and initiatives, and then livability indexes and gross national happiness, and how are those two indexes prioritize balance and weight between the impacts. Then finally, I'll wrap with one good way to compare and prioritize between impacts is to monetize the 'externalities'.

So, next slide please, Heather. I'm going to switch mind to presentation mode. All right, so for the overall introduction of the Transportation DIA. DIA is a systematic way to make sure that projects and policies contribute towards a country's development goals. It's crucial for developing countries and development banks to set development goals, and therefore they need to come up with metrics that enable them to track if they're making their way towards those goals or not.

Each country has different development goals, but the United Nations' Millennium Development Goals, which are those eight goals to the right, provide a good insight. They provide a good insight because a hundred ninety countries signed on to them and United Nations got a lot of consensus when developing these development goals, these Millennium Development Goals. The take home for those eight development goals is that they all can be categorized as either economic, social, or environmental and health. Those are the three categories that we're going to—last throughout this presentation. Environment and health are combined because it is a fuzzy to non-existent line between public health and environment. Then finally, transportation has strong impacts on all of these development categories so it's really important that we applied DIA to transportation projects.

Next slide, so transportation DIA has a bit of a changed per view in the LEDS context. So LEDS is focused on reducing the greenhouse gas emissions. Therefore, DIA in this context identifies and evaluates the link between low carbon transport and other development objectives. It's also referred to as co-benefits analysis. So if any you are familiar with that term, it's more less the same except for DIA recognizes that some impacts may be negative. They aren't at all benefits. Many of them are bad impacts. Third is it informs and supports transportation decisions and data-driven choices that really empowers decision makes with numbers where they can say, 'This project is better than this,' or, 'We shouldn't do this project because it will have a negative impact in this context.'

And then, you can be—the overall scope, DIA can be applied to transportation projects. It can be applied to transportation policies, or the entire transportation systems. It incorporates new partners that may not otherwise be interested in climate protection. That's one of the major benefits of doing the development impact assessments on one of these sectors outside of climate protection. Is this you can say, 'Hey, this

transportation project would further both of our causes. Therefore, why don't you support us? Why won't we become partners?'

Next slide, so the Breakdown of the Transportation Projects and Policies to be Assessed; the transportation projects in developing countries can fall into five main categories. One is new access to road or rail systems. Putting a new road into village that is never had one before. That's clearly has good economic benefits. Road expansion to increase capacity either some good benefits to that but however, those two—those first two categories increase the greenhouse gas emissions. So in the LEDES context, we wanted to focus on these last three categories that reduce greenhouse gas emissions.

One of them is to avoid kilometers travelled. This can be done through proper urban development planning and also transportation demand management projects. The second is to shift the kilometers travelled. You can shift them from individual cars to mass transit, or to non-motorized transports, different forms of transportation that had produce greenhouse gas emissions. Finally, you can improve the kilometers travelled. You do this through fuel economy technologies making. If you've got to drive an individual vehicle somewhere, you can make it more efficient and therefore, reduce the impacts that it has on many of the factors. Then you can all also shift that vehicle to drive on alternative fuels.

Next slide; so there are a variety of development impacts. I'd laid out the first—I'd laid out the main three categories as being economic performance of a projects, environment and public health, or social performances. So within those, I'm going to use the rest—the next section of this presentation to kind of follow along with these impacts and say how they are assessed and what tools they assessed with. So under economic performance, we are going to talk about cost savings for travelers and business. We're going to talk about return on investments, increased trade, private, and—I won't focus on them to much now because I'm going to re-mention them again. But yeah, I'm going to in the next slides, be talking about the ways to assess the impacts on—these specific impacts on development or on transportation projects.

Next slide, please. So as we are assessing those different impacts, they have varying degrees of sophistication for the system that are set up to assess them. Some very basic hard to assess ones, just have some studies in the literature where they have come up with relationships saying, 'Hey, in this country or in this community this had this impact.' And so for some impacts, the best you can do is to extrapolate upon those studies, and then once you get enough studies build up and to choose from, quite often people have published guides on how to assess the impacts. So those guides are series of steps to help you choose the best way to extrapolate and what data to use.

Then, the next level of sophistication is in different organizations have developed tools and models to help you through this process. It basically takes the guide. It codes it in software, quite often Excel. Quite a few of these are very user friendly. And it sets up all the relationships in the form of equations. It comes up with background assumptions for inputs that you don't know and then basically guide you through the data that you need inputs. And it tells you in a usable metric what the impact of your potential project or your policy is. The last level of sophistication and this only applies to a few impacts is that you can these tools and models and plug them in to a transportation demand model. I'll talk more about transportation demand models later on but essentially, they try to model your entire transportation system and they include feedback loops. So that's the ultimate level of sophistication is to assess an impact and plug it in to you transportation demand model.

Next slide please. So we're on to Economic Impacts, that first category of development impacts. So I just want to start out by asking the question, why assess economic impacts? For one, that is the presumed definition of developments or the old-fashioned definition of 'development.' The traditional definition is economically related. The Job Creation and other economic arguments carry a lot of political weight for most countries so it's good to have these impacts assessed that you can—that politicians can get on board and pursue economic improvements in their country. Assessments help compete for private sector investment and development bank funding. If you look at pie chart on the right, that's the breakdown on all the projects the World Bank funded in 2013. You can see that a good portion of them are centered around economic impacts. Finally, economic DIA appeals to portions of population that might not be motivated by environmental, health, or social benefits.

Next slide, please. So transportation projects and policies can boost the economy through five mechanisms and these are the mechanisms that can be tracked, that the impacts of these mechanisms can be tracked. The first is, reduce business travel and transport costs. The second is, reduce personal travel costs and that increases the customer's expendable income that they can spend within the economy. The third is to increase a business market reach for suppliers, customers, and workers essentially giving a business base to expand it by bringing the world closer to the business. It really gives its opportunity to expand. The fourth is to improve job access, and fifth is energy security that really helps the economy, and I will tell the end of these in the next couple of slides.

So, next slide, Heather. So to assess how personal and business travel costs are affected by development—or by transportation projects, you have to look at the fact that most money spent on petroleum leaves the local economy. So that's what the economists consider an economic loss instead of transfer. It's money spent on petroleum is generally a worst thing for the economy than money spent on, let's say, on refueling station attendants, or bus operators, or people better living in local economy and

as part of their job, they transport you from point A to point B. So, reductions achieved through avoiding, shifting, or improving kilometers traveled make businesses more competitive and enable customers to purchase more. These reductions are very quantifiable or these costs-savings are very quantifiable with numerous calculators and good default assumptions available.

So we can go to the next slide. So this is a subset of travel cost calculators that are targeted towards different audiences. That's what the second column over is the audience that it helps calculate their travel cost. You can see we have vehicle purchasers, fleet operators, road designers, just general companies, the commuters, public health officials, regional planners, and city planners. Then it also addresses different transportation projects. This include fuel economy improvements, alternatives fuels, traffic flow improvements, plug in hydroelectric vehicles, electric vehicles, idle reduction kilometers travelled, vehicle kilometers travelled reduced, eco-driving training, BRT projects, rails, bicycle, walking, BRT, and metros.

You can see that depending on what project you are wanting to assess. They have a pretty wide variety of models to choose from, and then it's also important to look at what the output is up on these models. Some of them report in cumulative dollar spent on owning and operating various vehicles and so I'll talk a bit more about that in the next slide. Some talk about focusing on fuel cost and compare fuel cost for specific trips. Some report in fuel savings of specific vehicles on various drive cycles that helps you assess and it helps you match up the right vehicle for the right drive cycle. Some are traditional investments—the investments assessments that tell you what net present value, the return on investment is, the payback period. Some tell you what—how much a ton of carbon abated will cost.

So you can see that for the different audiences, it speaks their language. These models give the outputs in the metric that they give an audience need to use. And then finally on the right hand column, I've done a preliminary ranking of these models based on difficulty. One is easy. Ten is difficulty. So you can see some of these are very easy to use. There—the easy ones are web based. The ones on the middle tend to be Excel—Microsoft Excel-based, and the more difficult ones either Excel-based and rely heavily upon macros or they are in some of other software format.

Next slide, please. This is a screen shot of a few of a travel cost calculators. The one on the left is the vehicle cost calculator. What those different lines are, are the cumulative cost of ownership. So, you can see that over the five years, all the vehicles are accumulating cost quickly because it assumes that you take at a five-year loan and so you're paying it back over those five years. And then after that you just have fuel cost, insurance cost, maintenance cost, and other operating cost. So this really helps people figure out what vehicle is going to work the best for them

when their choosing between two vehicles. Which one is going to cost the least in the long run?

The screen shot on the right is from FASTSim, which compares different drive cycles. This helps people—I used it once on a project where they were coordinating traffic lights, and so vehicles that are—their fuel economy depends highly upon what drive cycle they are driving on. For example in the US, vehicles driving on the highway are 35% more fuel efficient than vehicles driving on a city drive cycle. In most countries have a good representative drive cycle and quite a few specific cities do. So FASTSim can plug in that drive cycle and then you can take out various stops. There's ways to come up with specific city drive cycles using GIS but with FASTSim does as you can take up various stops and see how much your fuel economy will improve. It also enables you to match up the best—the most fuel efficient vehicle for your specific drive cycle and in your city and in your country.

Then that tool on the bottom, it's the MAC tool, the Marginal Abatement Cost Tool. Essentially that assigns a—that assigns a price to reducing a ton of carbon, and width of the bars tell you how much. They tell you the size of abatement, how much carbon can be abated. Then the links at the bars tell you the cost, and you can see some of them on the left are negative which means that the company doing this assessment will actually make money out of it. Then the ones that are at above the bar are—mean that there is actually going to be a cost. But this basically helps companies and other entities that are wanting and needing to reduce their greenhouse gas emissions. To see what the best—what the cheapest projects are to reduce a ton greenhouse gas emissions.

Next slide please. So, now into that next subset of economic indicators or economic impacts, we have the Increase Business Market Reach and Job Access. This helps to—so under this category, you assess the changes in sales, gross regional product or gross—sorry, gross regional product or gross national products, employment, and wages associated with transportation projects. These are the ones that are very politically popular. The politician can save that they've increased their gross national products, and this matched because of this transportation projects. They like that a lot. So these are generally assessed by 'input-output' models, which essentially say that when if you increase a certain group of inputs into your economy, then that will increase your outputs in terms of products and in terms of sales.

So this is one of those groups of models that are on the sophisticated side of things. So it's often tied to transportation demand models. However, if you don't want to or can't spend the money or have the data inputs to go that sophisticated route, there are guides that really help you. The guides which are shown here from the International Labor Office and the Victoria Transport Policy Institute really do a good job of highlighting projects or assessments that were done in other countries that are good to extrapolate



from, and they also help with models choices. You don't have to go directly to the fancy 'input-output' models and transportation demand models. There are some that will help you determine smaller subsets of the economic impact of a transportation project.

So we'll move on the next slide. I've mentioned Transportation Demand Models a couple of times. I think I heard someone. Yeah?

Sean Esterly Caley, this is Sean, just interrupting real quick. I think you and Heather got don't have the same kind screen of slides.

Caley Johnson Okay.

Sean Esterly Yeah, just let her know what number slide you are on.

Caley Johnson Okay. I'm slide number fourteen now.

Sean Esterly Fourteen, okay.

Caley Johnson Yeah, all right.

Sean Esterly Heather wants that just to go back one.

Caley Johnson Okay.

Sean Esterly There you. Sorry to interrupt.

Caley Johnson Thanks. No worries. All right, and so the Transportation Demand Models that I've mentioned a couple a times now, I'd like to dive into—yeah, I'd like to explain a bit further. So these are the ones that I've mentioned can be the backbone of many development impact assessments. There are smaller models that are focused on economic, environmental, and social impacts that can all plug in to the Transportation Demand Model. Most use four steps which I have on the—listed on the—here I have the diagram on the right here.

Let's start on land use data essentially is, is a region—where is the residential land use? Where are the jobs? Those are the big things. Where the commercial districts that people are going to be shopping? And then there's—and then that fits into trip generation, which determines the frequency of origins and destinations of trips by—in each zone. It breaks those down to trip purpose because for example, it'll line up a commuting to work trip between a residential and the industrial area, and then it'll line up a shopping trip between a residential and a commercial area. Then that feeds the trip distribution at number two on the diagram.

So this matched the origins with the destinations. They often use a gravity model function which in example of how a gravity model would work is say it would determine through—so the data input for this would be kind of your average demographics of, is it in a residential neighborhood? Or

like how many kids are in a given area? And so the gravity model would link children with the nearby school and say, 'Okay, they're going to go back and forth.' And then, that feeds the mode choice as part of the model. This is the mode choice. It just computes the proportion trips between each origin and the destination that use a particular transportation mode, and also takes demographic into account for example, people that are too young to drive, it will rely heavily on bicycles and buses. It'll also look at wealth. Quite often the wealthiest neighborhoods rely only on single occupancy vehicles. Then that mode choice portion loads into the trip assignments as a part of the model which allocates trips between origin and destination by particular mode to a route.

And then that will output the traffic volumes to which you can do a lot with the traffic volumes. It also has a feedback loop of a congested traffic speeds, which will basically feed into a travel time estimates because there's an element in here that knows that people are going to choose the mode of a—people are mostly likely to choose the mode of travel that takes the least amount of time.

So this model is much more complicated than any the others that we're going to discuss but I just want to keep that out of the way. If you didn't follow on that model, don't worry. You won't be lost in the rest of presentation at all. But I basically want to put this up there saying that, 'It's a framework for the most sophisticated DIAs to plug their analysis into.' So there are numerous for development or for Transportation Demand Models, and most of them come with contractor support. If you have someone on your staff that is a real computer whiz, there's an open-source model that's free. It's called TRANSIMS that was developed by another national laboratory, and it actually uses Google Earth as the geographic inputs. So it's pretty slick, but I will leave that Transportation Demand Models there and let's move on to slide fifteen.

Energy security is another major impact of the economy and this is primarily because price volatility kills business plans. If—there are many companies that fuel will be the dominating cost. One of them is airlines, and you can see what fuel costs do the airline. Bankruptcy is in that chart on the left. You can see there's a pretty tight relationship between fuel cost and airline bankruptcies. Fuel cost does the same thing to other petroleum-dependents businesses such as other—and such as freight delivery companies and other transportation companies. It just makes it really difficult to run a business and have a competitive business plan if you're depending on such a volatile fuel.

So the best way to reduce that volatility is to reduce your petroleum consumption. So you can do that through, for example, increasing your fuel economy. Twenty-five percent decreases your fuel price volatility by twenty-five percent. Same with decreasing your VKT, Vehicle Kilometers Travel, that's one to one relationship. Then you can also decrease that volatility by choosing different alternative fuels. And you could see on the

chart on the right that we, in the US, we found the majority of alternative fuels to kind of track the pricing of gasoline and diesel only that they tend to be slightly less volatile. Then the one fuel down at the bottom, there's actually two fuels at that don't track the price of gasoline and diesel. One of those is natural gas, which we have a lot of vehicles running out of compressed natural gas here in the US but a few other countries do also. So you can see that natural gas is much less volatile than the other fuels, and also one fuel that is not on this chart is electricity. We have an increasing in number of electric vehicles. Electricity isn't tied to the price of petroleum either. So those are two good options, two alternative fuels for reducing year price volatility.

Slide sixteen please. So now let's move on to the Environment and Health Impacts. Let's start this section with question, why assess environmental and health impacts? One reason that is recently come to painful light is companies are increasingly being held accountable for their safety and environmental impacts in developing countries. These really—this issue really become a hard topic after the Savar, Bangladesh garment factory building collapsed. There were multiple sources on the media kind of tying that collapse to the garment companies and people were boycotting the companies everything. So these companies that are producing in developing countries are been increasingly health accountable for the safety of their producers.

Another great reason to do impact assessments for environmental issues they are and so—and so impact assessments help out these companies. Because if someone—let's say, if an international health or labor organization says to a company, 'Hey you are producing in Bangladesh therefore you are abusing workers.' If they have the right development impact assessment, they can say, 'No, but we weren't abusing workers because—and so you could see our safety record.' It's the same way for transportation projects. There are ways to come up with safety estimates for transportation projects and policies.

Then, another reason to do impact assessments for environmental and health impacts are that many of the environmental issues are global. And so it draws a—they draw a lot of or you can draw a lot of international support with these impact assessments, and a lot of this international support has a lot of funding opportunities. Some of these are foundations such as the Clinton and Gates Foundations, the Global Environment Facility, development banks, carbon markets. They're just many—there are many big and powerful organizations and well-funded organizations interested in environmental impacts going on in developing countries.

Next slide please. So the first impact I'd like to look at this category is greenhouse gas emissions because that's near and dear to the LED's heart, and so we can assess the projects that avoid, shift, and improve greenhouse gas emissions. They—you need to assess the lifecycle, which means 'well-to-wheel' emissions of fuels. Essentially that saying that

when you're comparing different alternative fuels, you need to include the amount of energy and the amount of the emissions that were required to produce that fuel. So for petroleum, that would be all of the energy spent drilling, pumping, and transporting the petroleum to the right place. For bio fuels, it would be all the emissions in fertilizing the farm, harvesting the crop, processing the crop, and transporting the fuel to the rightful locations.

There are numerous tools and default values to calculate and compare greenhouse gas emissions from specific transportation projects. I'll show on the following slides. The Global Environment Facility Guide introduces good processes and tools. That's the guide that I have a screen shot of on the right hand side here. It's just a nice guide to kind of take you through assessing the greenhouse gas emission of different transportation projects.

Slide eighteen, please. So what are some of these greenhouse gas calculators? Let's look at—so just like the cost calculator, I have them broke them down according to what projects they're focused on and what audience they are appealing to. So for the projects, we have Alternative Fuels. There's this one, this GREET Model on the top here, covers with emerging and current alternative fuels. So that is a good way to, for policy makers to kind of determine if they should invest in research and development in alternative fuels. Then there's the simplified version of that GREET that's aimed more towards fleet operators. That just covers the existing alternative fuels that are already quite popular in the U.S. That's like ethanol, biodiesel, natural gas, propane, and electricity, and hydrogen. I covered in the simplified version of the GREET tool. And then there's a tool available online. By the way, I didn't include where to access these tools because basically, all these tools you can just cut and paste in the Google, and bring them up on their websites. That's the easiest way to access them.

There's the Petroleum Reduction Planning Tool, which is focused on fleet operators. That's the one I have a screen shot on the right. This is really handy and really easy to use. Essentially, you can see the stacking column charts that are on the right of the screen shot. Essentially, you set up a greenhouse gas or petroleum reduction goal and then you play around with different vehicle and fuel options, and also you can choose—at other projects you can choose are the reduce idling or reduce your mileage or to drive efficiently. As you plug those in your different vehicles, your how many miles a year they travel, it will calculate in the bar on the right hand side of the screen shot, will add up to your petroleum reduction goal.

You can see that—I wish I had a laser pointer. You can that the different colors of the bar correlate to the different colors at the top of the category field. You can see it's, the first one replaces vehicles. That's coded as green. Then, use alternative fuels existing vehicles is yellow. So it—does a

great job of helping fleet operators meet their greenhouse gas or plan how they're going meet their greenhouse gas reduction goals.

And then on the right hand side, I've included the screen shot of GREET. It's just basically to show how there are so many combinations of fuels, and fuel production pathways, and vehicles that you can make some match and they'll give you the overall greenhouse gas emissions. And then you can subtract that from traditional petroleum greenhouse gas emissions and those are your savings. So all of these tools have outputs that are in tons of CO2 equivalent reduced and the account for the full life cycle of the fuel.

Slide nineteen please. So, local air pollution is another one that—another impact that is really valuable to assess. There are many people interested in that and it's—there are huge health benefits associated with it. So what this diagram is, is the, it's the main steps to a health impact assessment to basically to bring you from the air pollutants which are—which there are a number of tools that help you determine that, the air pollutants from transportation projects which I'll discuss on the next slide. So those are going to be the input here on the upper left hand side. And then the overall process to bring the air pollutant changes to the overall health impacts in both mortality and morbidity. You take those pollutant changes among with the overall, the population risk. Essentially very young children are at extraordinary risk. They're at a much higher risk for or are much vulnerable to air pollution as are pregnant women and the elderly.

So, that box in the top middle essentially says, 'How many of these—how many people and in particular how many highly vulnerable people are going to be breathing these air pollutants? Or how many of them are close enough to breath these air pollutants?' So that's what develops your exposure estimates. Then once you have your exposure estimates, there are many studies that had determined the concentration response functions. That basically say, if this person let's say five-year-old child, for example, is exposed to fifteen parts per million carbon monoxide, chances are there's been a study that says that for every part per million carbon monoxide increase that that child breaths, there is a .02 percent chance that he'll develop asthma or there's a .0005 percent chance that he'll—his life span will be shorten. So those concentration response functions feed the overall impact on how many people are dying early because of an increased emissions—increased exposure to emissions, and how many people are going to be calling in sick to work, additional days and cost in the economy and things like that.

So, that's how you come up with your overall health impact estimates. Fortunately, there are two models that can help guide you through this and that add the correct numbers and fill in all the assumptions for numbers that you don't know or may not know. Those models are listed on the left, one of them is AirQ 2.2.3 and other is BenMAP. So those are definitely worth looking into. And then, there are number of models are that are much simpler that just evaluate the emissions from a project. So, that

enables you to evaluate the ‘before and after’ emissions, and therefore the emissions reductions from a transportation project. These models are on the next slide.

Slide twenty. There are more than this but these five are five of my favorites and listed as the same ways as the previous models. So there’s a Long-Range Energy Alternative Planning System, also called LEAP. This is a pretty big picture model for city planners. It’ll tell if a—essentially if a project—it’ll tell the increase or decrease in these emissions, these health damaging emissions. There’s the Motor Vehicle Emission Simulator, which lets you—it’s for policymakers. It lets you change the vehicles stock and see how that will improve your quality. There’s GREET. Also assesses these harmful air pollutants and then—and so that’s for alternative fuels.

Then the Transport Emission Evaluation Model for Projects, also called TEEMP, assesses the changes in emissions from bike sharing, bikeway, bus rapid transit, commuter rail, expressway, and pedestrian improvement projects. This is a subset of the TEEMP models that assess the carbon dioxide or the overall greenhouse gas emissions. So next, the reason that the TEEMP model was having range in difficulty is because each one of these project types has a different TEEMP model, and some of them are incredibly simple and easy to use and some of them are of medium difficulty.

Slide twenty-one please. So another impact that transportations system have is on the safety both of the people being transported and of the people just living in their neighborhoods. So mode shift is key to assessing mass transit. This chart on the left shows that there are different—so if you look at the million passenger miles that people travel on in a given—either on these types of on these modes of travel, before there’s one death. You can see there’s a huge difference. In light duty vehicles people tend to travel or people in the US in 2010, I should say, and there are statistics like this for many other countries, and light duty vehicles people travelled 200 million passenger miles per one death. Buses are ten times safer. They travelled 200 million passenger miles per one death. Trains are over—they are twenty and a half times more safer than buses at five thousand, and then airlines in 2010 and quite a few other year in the US were infinitely safer because they had no passenger deaths.

So, one of the major things that you can do—one of the major projects that can improve passenger safety are just promoting mode shift, promoting people to shift from likely the vehicles to buses. And it’s very easily quantified by, if you have one hundred or if you have a hundred thousand people that shifted from light duty vehicles to buses, you can say that you decreased their chances of mortality by ten percent based on this chart or another chart from your country. And then, bicycle and pedestrian projects are a bit tougher because there’s no way to tell exactly how far they travel.

So, pedestrian bicycle is—have their own indices and one very good guide that helps you assess the safety improvement from given projects is this one I have posted on the right here, the pedestrian and bicycles intersection safety indices. It focuses on intersections because intersections, because that's where the vast majority of accidents happen for bicyclists and pedestrian. So I recommend if you are pursuing a bicycle or a pedestrian project, I recommend that you look at this guide and let that help guide you to assess the impact, the safety impacts that the project will have.

Next slide. So exercise increase is another way of transportation projects can really improve the health of the population. The relationships between land use mix, multimodal communities, time in car, active transit, obesity, multiple diseases including heart disease and coronary disease, and longevity have been pretty well established in the literature and in studies. So, this chart is to the right is one of the examples of one of those relationships that were established in the study. You could see it relates the probability – Oops. Excuse me. I have to sneeze. It relates the probability of obesity to the minutes spent in car per day. This is an example of one of the many relationships that can be quantified into calculation and wrapped it to a model that you don't have to worry about it, and it will just do the calculation for you.

The only model that I was able to find that does these calculations for you is the Health Economic Assessment Tool called HEAT, and that's for cycling and walking and that was developed by World Health Organization to quantify the health and other benefits. So, yeah, so that model will help determine—you know if you have a project that is going to increase the amount of people walk or bike instead of driving their car, they'll help you assess how much healthier the people will be. It also brings it to the next level of cost savings because it has another level that says, 'Okay you know, if someone is obese, there health cost or this much more than some that's not obese. If someone that develops heart disease has health cost and it is much more than someone that doesn't.' So, that model is key to assessing the impact of exercise increase.

Next slide please. Let's move on to social impacts. These are probably the least popular for it to be assessed and kind of the least systematic. However, they are very important so let's ask, why assess social impacts? I kind of like just at the emotional level at looking at these two pictures. I feel like they really highlight the differences between the car culture versus pedestrian culture. And pedestrian culture also applies to public transit and basically anything that reduces car culture because that makes pedestrians safer. You can see in the car culture picture that was taken from a road rage website that typically cars are driven with just a single or the least efficient transportation system. The kinds that we wanted to be replacing are characterized by single occupancy vehicles. You know, just one person in there lonely, having no human interaction except for when they get angry at the cars around them. That's to be contrasted with picture

on the right of the—you can just see the social interaction going that pedestrian and other forms of transportation facilities.

So, many ‘developed’ nations are unhappy and unstable despite strong economies and healthy environments. That’s largely because of the way they developed has not taken social impacts into consideration. In many places, the local society is deteriorating even more quickly than the local environment, another reason why social impact should be heavily weighted and heavily assessed. Most happiness studies which—I don’t know if any of you have dug in to the happiness studies but they actually are pretty stringent and rigorous in its—and they actually have really boiled up them down to quantified methods of assessing happiness and assessing what activities increase or decrease happiness in certain amount. So, most happiness studies have shown that human interaction that is the number one driver of happiness, and human interaction is highly interrelated to the transportation system as shown in the two pictures below.

Let’s continue more on the next slide. I have few more reasons to assess social impacts. One is that powerful interest groups are based upon social impacts. There are many people promoting gender equality, or handicapped equality, many groups advocating for children so they can be good allies to have. Foundations are very interested in social impacts. To come to mind again are the Gates Foundation and the Clinton Foundation. Much of development bank funding goes towards social impacts. And those in—I’d like to highlight the World Bank Projects funded by theme 2013 again. You can see quite a few of these are related to social impacts and would be interested in social impact assessments. The civic engagement definitely falls on the social category, the gender, education for all, conflict prevention, and other social development. That’s a huge portion of the World Bank is funding. And it’s great to be able to—and it’s great to be able to speak their language and social impact will be able to enable you to kind of give the World Bank and other project funders’ sales pitch on why they should be interested in funding the transportation project that also happens to reduce greenhouse gas emissions.

Next slide please. Accessibility is another social impact that can be assessed. So impacts are typically rated—the accesses to three major services are typically—they are typically rated. That’s the basic services such health care, education, childcare, and public safety. These are weighted the most heavily because they’re the most fundamental to existence, to the humans existing, living good lives. Then there’s quality-of-life destinations such shopping, recreation, worship, and cultural centers. And finally there are markets that include the employers, employees, the suppliers, and customers, and places where you want to shop.

There are four measures of accessibility. One of them is the change in travel time to given location. So if the transportation project is put in place



that reduces, let's say reduces people's travel time towards—to the hospital by half an hour each way, that can tallied up and written as an impact of the project. Another is the change in travel costs to a given location. This is important because a lot of people can only afford a certain amount in order to travel to a location. So this is—this fundamentally puts this location on their radar screen and makes it available to them once it reduces the travel cost to get to it. Another measure of accessibility is the change in number of choices to a given location. So this is basically saying that the more redundant the system is, the more accessible a location is to a given location. And then finally, the changes in market reach for businesses.

These can be assess through interviews, focus groups, surveys, and site analysis that can really fill in the picture for much that even that the models miss, and then weighted the accessibility values are estimated by the gravity models. Those gravity models are the same ones that I briefly introduced earlier that linked up certain demographics with certain locations that they would commonly be going. I used a student-age population with a school for the example, of how gravity model would link up people, people to locations. And then, travel demand models forecast changes in aggregate travel time and distance. So this travel demand models are the ones that give you the good outputs saying that this transportation project would save these many hours of travel time for this given population.

Next slide please. Let's dive in a bit more deeply to the Travel Time Savings. So travel timesavings are the fundamental—they are fundamental goal for many travels and transportation projects. The overall goal is minimizing the number of hours that people are spent isolated in congested traffic. And so essentially, an hour spent in your own car being stressed out in traffic is not equal to an hour spent walking with your family when transporting and so it brings these different weightings and a lot of these assessments wrapped it all up in a dollar figure. They convert the hour spent in different means of transportation over to the how much money that hour was worth. So it provides a good common metric. So travel demand models can usually minimize travel time. It's a common feature in most travel demand models.

Savings calculated as difference between pre-project infrastructure and post-project. It also important to reduce variability in travel time because essentially if you are waiting for a bus and there's a half an hour window that it may come in, you're going to have to arrive about half an hour earlier than the bus stop. So that came up just the same as if you are on the bus for an additional half an hour each day. There are well established methods determine the value of travel timesavings. So that's in the power lens of the industry experts. It's called the VTTS and that's a common metric that is use throughout the literature and on these models. These methods are to determine the Value of Travel Time Savings. They're based on income, comfort level, the ability to multi-task. For example you

are in a bus, doing work or you're transporting or you're being stressed out in a car all by yourself, or are you biking then therefore exercising at the same time. And so these models boiled it down to a time cost savings estimates that can be easily compared between transportation projects.

Another impact is on community cohesion. This is used to describe patterns of social networking within a community. Is the community tight? It's very important to our human nature to be—it's—we're basically wired to need certain amount of community and interaction, and community can also make people lot more resilient to the challenges and to catastrophes. So, this community cohesion impacts are the least systematic assessment methodologies and there aren't any models. A lot of it can be done through interviews, through site visits, and overall—yeah, I think interviews and site visits are the best ways to assess the impact that the community could—that the projects would have on community cohesion.

So, the attributes to keep in mind of a pro-cohesion project are it doesn't require location or relocation of residents and businesses. It doesn't pick them up and move them outside of that community. Overcomes a physical barrier, or at least doesn't divide a highly cohesive neighborhood with a physical barrier. An example I'd like to site on this is that, I used to live in Washington D.C. The U Street neighborhood was centerpiece for the African-American community. It was very valuable to them and when we put the interstate highway system in, in the US, it was proposed to go directly to through the U Street neighborhood and bisect it. Then community and many sociologists stood up in arms and protested that plan and they are able to get that and put the interstate to another location so it preserved that community. So that was the case where a community—where an impact assessment on what would happen to the community cohesion actually saved the community.

In similarly, communities can—if they're already has been a mistake as there is in—like many, many locations where major highways bisect communities. Small relatively cheap projects can include transportation bridges across these highways and just different and other ways to connect the community. Another impact to transportation projects have on community cohesion is traffic noise, dust, and hazards quite often prevent people from socializing outside. It drives them back in to their houses in relative isolation. So that needs to be taken into account. If the project protects cohesion of a poor neighborhood, that is—that should be weighted more heavily than protecting cohesion of a rich neighborhood because there had been studies that showed that the poor are more dependent on their immediate neighbors and family living closely in their community. So those factors should all be taking into account when looking at community cohesion.

Equity is another is another factor that should be taken into account for transportation systems. I'm sorry. We're on slide number twenty-eight. So increase choice of modes is key to an equitable transportation system. I'm

going to hurry and finish up my slides so we'll have some time for questions. Bicycle and pedestrian 'compatibility Indices' are different than 'safety indices' because they take convenience factors into account. For equity, you need to look at the 'Barrier Effect' for roads and rails. That's quantified in terms of additional travel delays or experienced by age specific pedestrians and cyclists.

So essentially, when assessing the equity of transportation project, you can look on that table on the lower left and assess the transportation mode that you're going to be improving or damaging and how that affects this different groups, the non-drivers, low income, the disabled people, and then the general commuters. This table essentially says how these different groups would be—how projects affecting the transportation modes would affect these different groups.

Slide number twenty-nine please. So we have all these impact and the big question is how to prioritize them? And the big answer is that it's really up to the developing country on their development plan and their development goals as to which they prioritize. But there have been some—but two examples of ways that groups that have tried to systematically prioritize them have been the livability indexes, which you can see on the left hand side. The Economist Intelligence Unit has a livability indexes that this really well respected. That's the Economist Magazine, is the source of that. And so they weight twenty-five percent towards the ability which largely means 'safety', twenty percent towards health care, twenty-five percent toward culture and environment, ten percent towards education, and twenty percent towards infrastructure. So these groupings don't—they aren't exactly the same groupings that we use throughout the earlier part of the slide show. However, you can really see how the different impact assessment can be grouped according to these groupings.

Then another place that I want to look for prioritization of the different impact is Bhutan with their Gross National Happiness Indexes because they've done the best job at incorporating a lot of the externalities that they come from—that come from the impacts that we've been discussing. Unfortunately, Bhutan just weighs them all equally as can be seen in this Venn diagram on the right here. They have nine domains and thirty-three indicators of Gross National Happiness, and that fit a lot of the categories that we've previously that we discussed earlier in this presentation. And they just rate them all equally with. But you know it's—we're at the pioneering stage of weighting these and comparing these indexes all together.

Finally, one good way of doing it is converting the metrics of the various impacts into currency. This is a pretty robust field of study. A lot of environmental health and social externalities have well-established quantification methods. Timesavings is usually converted to money. Road safety, air pollution, lack of exercise, all that means of converting to

money and accessibility can be converted to money. So you can prioritize projects based on their value.

Next slide, we're at next slide thirty-two now. In conclusion, Development Impact Assessment identifies and evaluates the link between low carbon transport and other development objectives. One reason to do DIA is to incorporate new partners that may not otherwise be interested in climate protection. Numerous economic, health, environmental, and social impacts have well-established ways to assess—to be assessed. The studies, guides, and tools available for assessments depend on the impact and their relative sophistication. Prioritizing impacts is up to the country, but some systems are being developed. Impacts are increasingly being converted to currency in order for broad comparison.

That's the end of the presentation. I have some contacts on the next slide that have more information and my contact information. I'd like to take questions now, and also you can contact me at the listed email address and phone if you think of questions later.

Sean Esterly

Thank you, Caley. Heather, let's leave Caley's last slide up while we do the question so that the attendees can access those email and other contacts there. We did get a couple of question from the audience, Caley, so go ahead. But we only have a couple minutes left. The first question is do you see—before on one of your earlier slide, you're talking about the volatility of different fossil fuels and you mentioned electricity. Do you forecast that as electricity powered vehicles become more use and more popular, could their volatility increase? And in regards to United States, if our electricity generation switches over to natural gas, could this affect volatility and price of electric-powered vehicles?

Caley Johnson

That's a good question. Heather, if could you bring up slide fifteen. So essentially I don't—so the reason that natural gas on that—turn on slide fifteen. The reason that natural gas doesn't track with all the rest of fuels is because their price is driven by relative demand to—it will it—sorry, because the other fuels are primarily transportation fuels, and therefore they get tied to gasoline and diesel. Compressed or natural gas at least in the U.S., less than 0.2 percent of the natural gas in the U.S. is going towards natural gas vehicles. So that's completely different market and even smaller percent of electricity is going towards vehicles. And so that would—and so that's the main reason why electricity doesn't—isn't as volatile as—isn't as volatile as all the other transportation fuels.

So essentially, we use so much natural gas. We're using more and more natural gas to produce electricity that I really can't see—I can't see vehicles using a substantial portion of our natural gas in the foreseeable future to the point where natural gas price would fluctuate as widely as gasoline and diesel. I can't see us getting to the point where either natural gas or electricity prices would be dominated by vehicles, and therefore attract diesel and gasoline prices.

Sean Esterly All right. Thank you, Caley.

Caley Johnson Sure.

Sean Esterly This is a tough one to answer in a minute but if you could tackle this question as quickly as possible because we're down to our last couple of seconds here. Which section would you consider the most essential for a wide-ranging transportation project?

Caley Johnson I would say that the timesavings assessments is the most essential and that's—and one of the reasons is because timesavings is so popular. It's something that I didn't really elaborated on the slides, but all of these assessments need to kind of related back to popularity of a given project. And any given transportation project needs to be accepted by the population that it's been given to, and therefore fed up towards—therefore their satisfaction and their taste would feed up to the politicians that are enabling that and the funders. So, I think timesavings is pretty fundamental. It is a pretty good indicator for how popular a project is going to be.

Sean Esterly All right. Thank you, Caley. I just want to thank you again for the great presentation today, and just thank our audience. We do have a brief survey for them to take. Heather, if you do bring up the first question please. The first question that survey for the audience is the webinar content provided me with useful information and insights. And the second question, the webinar presenters were effective. And then the last question is, overall the webinar met my expectation.

All right. Great. Thank you for answering our survey. And on behalf of the Clean Energy Solutions Center, I would just like to thank you, Caley, and our attendees for participating in today's webinar. We had great audience and I appreciate your time. I invite our attendees to check the Solutions Center website over the next few weeks. If you'd like to view the slides again and also listen to the recording of today's presentation as well as any previously held webinars. Additionally, you can find the information on upcoming webinars and some other training events for the future. We also invite you to inform your colleague and those in your network about Solutions Center resources and service including the no-cost policies support. I hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.