# ECONOMIC DEVELOPMENT FROM WIND POWER: RECENT RESULTS FROM TWO NOVEL STUDIES THAT QUANTIFY IMPACTS FROM EXISTING PLANTS AND INDUSTRY ACTIVITIES

**January 16, 2013**

Coordinator: Welcome and thank you for standing by. Today's conference is being recorded. If you have any objections you may disconnect at this time. Parties will be on a listen-only mode.

I'd now like to turn the conference over to Mr. Ian Baring-Gould. Sir, your line is open.

Ian Baring-Gould: Good afternoon everybody. Thanks again everybody for joining us for another Wind Powering America webinar hosted by the Department of Energy. This one we're going to focus on the economic development of wind power and have a number of presentations that look at exactly the economics of wind energy development as well as the workforce around wind energy.

So we've got two speakers: Cai Steger who is from the National Resources Defense Council and then Ryan Wiser who most everybody knows from Lawrence Berkley National Labs. But before I jump into their two presentations I wanted to give just a quick minute overview of the different types of work that the Department of Energy is doing in the workforce space to kind of put this a little bit in context. And then at some point we'll be doing another webinar at some point in the future kind of looking at as that research gets through talking about those different activities.

So quickly, so we don't delay too much from the other presentations but the Department of Energy's market acceleration deployment work is really looking to understand what the workforce is for wind and then also doing

activities to inspire the next generation of wind professionals. So from a workforce development activity there's a couple of things that are happening.

The first one for those who do not know is the annual wind competition the DOE is launching. Requests for proposals went out just last week for universities that are interested. This is going to be an undergraduate-level wind competition that hopefully one day we'll see get as big as the Solar Decathlon, but we'll see. And it is a challenge that's made up of three different events all around the development of a small backpackable wind turbine to charge small electronic devices. So any universities that would be interested in this competition go to the Wind Powering America website there's a news release right there that directs you to our fee instructions.

The Wind for Schools event is our second big activity, which people are pretty familiar with. As of the end of 2012 we're active in 12 states and had over 130 installs at K-12 schools as well as quite a few students both at the university and then at the K-12 level impacted. The development of the wind application centers that are training university-age students, both undergrad and grad student in wind and then the National Skills Assessment that I'll have a slide on in just a second.

Certainly we're continuing to do work in the JEDI model—which clearly has jobs and economic development impacts—including the release very shortly of the offshore wind JEDI model and then a new one for small and distributed wind, that'll be coming out relatively soon. University-led research consortia at a number of academic institutions and then not on here because it's just in the development is again trying to support the NAAWE, the North American Academy of Wind Energy, which is another activity that's going forwards.

The National Skills Assessment is an activity that has been funded by the DOE over the last year and the research is primarily is being done at NREL to try and get a much better assessment of what the workforce is. People remember the 20% report gave a projection of what the wind workforce is but since that time there hasn't really been any detailed assessment of what the workforce is made up of. Broken down into two parts, one is company survey of the industry—and as you can see here we got responses from 418 companies that are in the utility-scale side of the wind business—and then we're also doing a survey of academic institutions to understand what is available from a training perspective.

Preliminary results kind of give a breakdown of what the wind workforce is. NAAWE projects that the current workforce is in the neighborhood of 75,000. In our survey we were able to clearly identify 46,000 workers that are clearly directed and we could kind of break it out into this pie chart here understanding exactly what their job is but also what level of education they needed to perform these jobs and then whether that needed to be a wind-specific engineering degree or a wind-specific wind technician degree or whether it could be something that was more generic.

So we'll have a number of papers coming out about this but just wanted to let people know that that was happening and we'll get some more information. And then domestic wind-manufacturing facilities information is included in the annual market report that Ryan is a primary author on but kind of continuing to understand what the manufacturing space is going forwards.

So that this gives you a quick overview of activities that the Department of Energy is doing to support understanding and implementation of the wind workforce. And so without further ado we'll jump into our presentations that delve much more into the economic development impacts and job impacts of

wind energy. So it is my pleasure to introduce the first speaker, Cai Steger who is the Associate Program Director for Energy and Transportation at NRDC where work primarily for advocating for policies that drive clean energy, innovation, investment and deployment and research of economic impacts on the renewable energy technology space.

Recent projects include analyzing employment and localized economic impacts of wind projects, which is what he's going to be talking about here, as well as looking at federal deployment mechanisms for large-scale distributed generation. So a fair amount of work in this nature.

Cai joined NRDC in 2008. Prior to that he's had quite a few jobs focusing on research and then strategy from the private sector. He comes to us with a MBA from Columbia and a B.A. from UC Santa Barbara, so we've got a California crew in our two speakers. So without further ado, Cai, please.

Cai Steger: Thank you very much and I appreciate the excitement you brought reading my bio there. So I'm Cai Steger. I work at the National Research Defense Council. For those that don't know, we are a national environment defense group with about 1.2 million members and about half-a-dozen offices around the country. We focus on a wide range of environmental and energy-related issues. My role at NRDC is primarily as an advocate and analyst, looking at renewable energy policy and economic issues. But especially recently I've been spending a lot more time thinking about communications and how we talk through a lot of what's happening in the renewable energy sector.

So during this presentation it's really two goals here. One is to present a couple of wind reports that we developed and published last year during the height of an interesting election cycle, and the second is also to talk about the

communications context for these reports and how we developed them with that in mind and how we used them.

So I'll kick things off. I like to start with this picture, it's one of my favorite pictures. Not sure what that says about me, but, you know, it's this powerful crystallization of a lot of the economic messages we like to use to connect to potential supporters of wind energy. There's a lot of stuff happening here: there's kind of this classic image of the American worker 400 feet up in the air. You can almost draw a straight line to the skyscrapers from 100 years ago that they would build in New York City. You've got guys on scaffolds, you've got American engineering and manufactured design here. And then, you know, evidence of just how America builds big things really well.

And then, you know, you get a lot of sense of the economic impact from this kind of image, for the things that wind energy can accomplish in communities, and also for the size and scope and complexity of these structures. Unfortunately, this kind of economic message isn't always being reflected in what the typical American thinks about wind energy. And that's not from a lack of economic analysis: there are a number of very valuable studies out there that quantify the economic impacts of wind energy, provide a lot of really important learnings. Ryan's study that will follow this one is kind of a classic example of just some exemplary scholarship.

The challenge for us as advocates—for me as an advocate of renewable energy—is trying to convert that scholarship into relevant messages that the normal non-wind energy expert can get their heads wrapped around. And so I'll briefly run through a couple of slides here in terms of where voters are to try to highlight what led us to develop the wind reports the way that we did.

First off, none of this should be new to folks, the idea that people support renewable energy extensively: numbers range from 70% to 90%, depending on how you ask the question. And also you're starting to see that the jobs message is coming through on a general level: the people see jobs as a net benefit from renewables.

At the same time, however, there is some nuance that we're seeing, and it basically can be boiled down to the idea that people have a vision of clean energy and what it's going to mean in the future, but they're not actually seeing the reality of these jobs being created now. They're not really understanding the amazing things that are happening in the here and now. And as a result that's, you know, limiting, I think, the passive supporter from being more of a direct advocate.

Just a couple of examples here to demonstrate that. If you ask voters current benefits they associate with renewables—this was from a poll a couple of months ago, the one on the bottom left—you see job creation and economic growth are there but they're not ranked very highly. To the right there were some focus groups done by a group called Third Way in Iowa and Ohio surfaced the same kind of idea. The participants saw clean energy creating jobs, but not in the short term. They thought it was a 10 to 15 year cycle and that it wasn't happening today.

Our hypothesis, building off that, is really that we believe that there's a lot of great things happening in the renewable energy sector, and we have a lot of evidence that we can marshal to demonstrate this taking place. And by doing so—by demonstrating all of these, you know, positive economic impacts that are happening now—and importantly using independent validators, voices people trust, independent voices like businesses, like workers—we can move the needle and we can really turn a passive vote into an actual advocate who

doesn't just support renewable energy but will actually advocate on the policies that matter. Same thing with politicians.

I won't belabor the evidence. It's not groundbreaking. Basically, where you see a lot of renewable energy you see bi-partisan support. When people are exposed to it and they're aware that it's happening in their town, there tends to be more, you know, support. In Iowa there was a bi-partisan coalition in support of the PTC. In Ohio, where there's been a lot of clean energy development recently, you see something similar happening.

All of this is a long intro into these two reports that we developed. In the first one, in American wind farms on the top left, we wanted to conduct a robust economic analysis that would give us actual data that we could talk about in terms of what wind farms and what wind energy was bringing from an economic perspective. But what we chose to do is not to tell the story in terms of the whole sector or in terms of making projections about future growth and coming up with a large number: rather we just focused on one wind farm.

And essentially we thought that by just using a wind farm to tell a story we'd be able to address some of the unfounded criticisms about wind farms only creating 10 to 15 jobs. But we'd also have a narrative tool that we could use to demonstrate how these wind farms get built, their overall impact, the many different stages that they go through, and the length of its life cycle. And that was the approach we chose there.

For at-wind speed, on the bottom, it was the compliment to this report. Where we then took the idea of this wind farm and we highlighted the community benefits that would come from this wind project. We used four case studies of four different communities that were benefiting from wind in their district or wind in their community and then illustrated some of those benefits.

So, you know, to step through more on the technical side of things—how we ended up on the economic side of the analysis—what we did is we broke the entirety of the wind development cycle into 14 steps, based on categorization that had already been developed separately by NREL, National Renewable Energy Labs. But, you know, as you can see here it doesn't completely come through on this slide unfortunately but there's, you know, we measured everything from when you're out there on your tower measuring the wind to when you're going through on perimetering—when you're actually building it, connecting it to the grid and finally maintaining it.

And in each one of these 14 steps we surveyed companies that operated in that step and asked them to give the potential labor impact for providing goods or services to a 250 megawatt wind farm. And then we calculated the jobs based on each of those steps. And then within each of those steps we did a deeper dive to get an understanding in terms of what was happening in terms of the workforce and in terms of the types of jobs that were being created, which I'll cover in the next slide.

All told we surveyed 120 companies. It was a limited sample set for this kind of study but the responses were highly clustered, which gave us some confidence in the results. Long story short, when we aggregated this stuff along the categories every 250 megawatt wind farm that gets built, we are confident to say that nearly 1,100 jobs are created. And if you break that down into non-construction or construction categories, 532 jobs are created in construction, in building this kind of this kind of wind farm, and 557 jobs are created in non-construction roles, including over 400 in manufacturing.

The idea again is just to lay this type of job analysis out in a simple and visual way so that readers would get a better sense of the overall picture and how

jobs were spread across this project. And the idea that you'd only be creating 10 or 15 jobs at the end of the project just didn't really apply when you looked at the multi-year cycle for a wind project.

There is an important caveat here, which is just, you know, this isn't an analysis of the sector overall, you can't aggregate these numbers up and come up with a picture of full wind industry employment. It's not designed for that. NAAWE and NREL and others, those are the guys that do those kinds of surveys. This was just focusing on a wind farm to try to get it—the job and economic impacts from there.

Briefly moving to the next slide, this is just an example of how we looked at each of the steps. In addition to talking about the jobs that were created, we also talked about the types of jobs and the responsibilities and skills that would be needed for that kind of labor. And then finally you can see it's a bit cut off, we profiled a company at each step along the way.

Either an American company or a foreign company with a strong domestic presence: the idea being that if you built, you could see as a reader going across the report the many different steps, the many different types of jobs and the many companies that were involved. All told we wound up profiling 13 different companies, in addition connecting each one of these to a step of the build out of this wind farm, each one of the different steps.

The idea here was to profile local stories to provide local-relevant content that would be helpful in terms of communicating what wind farms are doing here—here's a company in your area—but also just to generally get across the point of the strong potential domestic benefits that you got from a robust U.S. wind industry.

The book-end study, which was at-wind speed, again, this highlighted the community benefits, we showed the case study here. I'm not going to go through all of the data points because this has been a number of times and I think they're all very helpful when they're conducted. From our perspective we wanted to provide a little more context for how wind farms are being created in the country but also to serve up anecdotes and examples of how communities were benefiting from wind in ways that helped us promote and publicize this report.

My favorite study—my favorite example from Livingstone County—is they created a $6,000,000 economic development fund from the original development fee from their wind project and during the height of the recession there was a local auto dealership that was going under and was able to get a loan from this economic development fund, stay open for business, keep the 29 jobs that they were responsible for and is now flourishing. And it's an anecdote and it's not particularly empirical in terms of how it talks about impacts, but I think it provides a powerful example for how symbiotic the development can be in specific communities.

Canton, Ohio, was another community that we looked at. In this instance we just wanted to highlight how communities can transfer existing expertise and skill sets into other contexts. And so Canton has built up a little mini-wind energy cluster of 19 companies and we really wanted to get that out there and talk about the benefits also that come with that.

And so the results of the wind reports from a communication perspective and from an advocacy perspective, I think they were quite positive considering that this is a somewhat esoteric subject and can, you know, be somewhat challenging to communicate. Certainly we got support from policy makers that have shown support for these kinds of technologies. We got, I think a

good-sized media result. And especially in addition to the national press what we were most excited by was the local press, the Plain Dealer from Ohio, you know, really being able to kind of take these stories and this idea of wind's benefits down to the local level and have it surface in this kind of earned media is what we were hoping to do and we were happy with that result.

And I'll close just briefly on some lessons learned from this analysis, and I'll just touch on a couple here. Certainly, you know, as you might have guessed we're proponents of combining robust analysis with this positive narrative. The idea being there's some great stories to tell, but you know, can be more effective if you're trying to do advocacy, as we do, if you're able to step outside of being wonky and very technical, and attach it to local-relevant content that people can wrap their heads around that tells success-story or two in their region.

And building on that, the last bullet, the idea of developing localized content: the reason for profiling all of the companies that we did. One of the reasons, and the reason we chose to talk about wind employment and wind's economic benefits, and, you know, the way we did and the reason that we used the case studies is it gave us local material. And, you know, as advocate when we're trying to promote the benefits of certain technologies, having that kind of material can make it much more effective. So anyway, thank you very much for your time. Hope that was helpful.

Ian Baring-Gould: Great. Thank you, Cai. Great presentation and great analysis. Next, again, before we jump into questions, we want to have Ryan join us. Ryan really doesn't need any introduction but I'll do it anyway. Ryan Wiser is a staff scientist and the Deputy Director of Electricity, Markets, and Policy Group at Lawrence Berkley National Labs. Ryan leads and conducts research in so

many different areas looking at planning design, evaluation of renewable policies, cost benefits, market potential of renewable energy.

To say Ryan has looked at everything is probably not too much of an overstatement. Whenever we start looking analyses we should do, the first thing you always do is call Ryan and say, "Hey Ryan, what work have you done on this?" And then he tells you and you go on from there. So he is certainly a national resource in the analysis of renewable energy.

In addition to that analysis, though, he regularly advises states, federal government, and international governments on renewable energy, including many different organizations within the U.S.: World Bank, other organizations and then certainly DOE. He also, in addition to writing hundreds of papers, was a lead author on inter-governmental panel on climate change which was a very impressive work looking at the impact renewable energy can have on the issues around climate. Ryan holds a B.S. in Civil Engineering at Stanford and then the M.S. and Ph.D. in the Energy and Resources from Berkley. So a wealth of experience and always wonderful to hear what new analysis Ryan has conducted. So Ryan, please fill us in.

Ryan Wiser: Great, thanks Ian and thanks to all of you for joining. That introduction was great. It makes me feel extremely old, however. Nonetheless, we will proceed. Thanks also to Cai for a great presentation. I think that you'll see that what I am presenting here is that it's complementary in many respects but that it also has a very different audience. So that while Cai's work and analysis he just presented really intends to have an external audience and a broad audience, the work that was conducted and that I'll be summarizing here by a whole team of folks, it really intends to have a bit of an academic audience.

Now I'm not going to—hopefully—totally bludgeon you with this economic analysis. I'll try to identify and point out the high points of the study and its findings. But nonetheless it's important to understand that we have a rather different approach and audience than the one that Cai just described.

In particular, the work I'll be presenting today explored statistically or econometrically the impacts of wind development on county-level income and employment. Before I launch in I do want to acknowledge all of my co-authors and contributors, the study was really a three-way collaboration between the USDA's Economic Research Service, Lawrence Berkley National Lab, and NREL in the form of Eric Lantz. And I want, again, to acknowledge all of the co-authors here. Obviously I will be presenting the work but everyone played important roles. And in particular Jason Brown from the USDA was really the core analyst behind the work that I'll be presenting today.

Now the motivation for the study was in some respects similar and in some respects different from the study that Cai just described and NRDC performed. First, I think that all of us know on the line: wind energy clearly has grown substantially in the recent years, with some of those statistics provided on this slide that I'm sure all of you have seen in one way or another.

Second, though, a lot of that deployment has occurred in part because public policy makers and local communities understand that wind energy may provide local economic development benefits. Clearly the possibility of local economic development benefits has been one of the motivating factors for policy makers and local communities to be interested in supporting wind energy development. Now those economic development impacts at a magnitude, or a range of geographic scales: the possibility of very local

economic development is certainly especially salient in rural areas where wind power plants are most often constructed.

Third and finally, though, while there certainly has been a lot of work that's been conducted on the local economic benefits of wind, project-level case studies of a nature similar to those done by Cai and NRDC, as well as input/output estimates of the form generated by the NREL JEDI model. Notwithstanding that literature, there still are concerns about whether these impacts exist, the magnitude of these impacts, the distribution of those impacts, and the durability of those impacts.

And those concerns might exist at the national, state, and local levels. So while Cai's focus was really in trying to communicate these possible benefits to a broader audience, what our goal initially was was primarily communicate them within a narrower academic audience. Though I hope I've convinced you by the end of this presentation that our findings have important benchmarking purposes beyond the academic audience that some of the focused towards.

So given that background motivation, the research question that we sought to answer is as written here: "What are the observed county-level personal income and employment effects from wind power development?" The approach that we used will be described in a lot of detail later—maybe too much detail for some of you—but in summary included an econometric analysis of county-level personal income and employment from past wind power development that occurred within the 2000-2008 timeframe in a large 12-state region of the country.

The really unique aspect of the work that I'll be describing is that it allowed us to evaluate actual county-level impacts from a large amount of wind

development over a significant portion of the U.S. So it's an anti-analysis: we're looking at what happened in the past but we're doing so not through individual project case studies but instead in looking at the range of wind power development that's occurred over a very significant part of the United States.

One aspect of that is that it also creates an opportunity to compare the results that we come up with to previous input/output estimates and so are able to test at least loosely the validity of certain input/output tools, such as the NREL JEDI model.

Now to be clear our focus was on net impacts from wind development on the county-level, focusing on those counties with wind power development activity. Our work really does not seek to inform the very real and important debates that exist on the net effects of wind on income and employment on larger geographic scales, whether at the state level or nationally. We're really focused on the county-level or local impacts.

Now regardless of what methods are used to evaluate possible local development impact from wind I think it's important that those methods at least acknowledge and to the extent possible capture the rather significant myriad of impacts that wind might have on local economies. Some of those impacts are enumerated on this list. I'm not going to go through all of them, but they include of course direct employment and income associated with those employed in the wind industry, either in construction or in operations, a demand for local goods and services from the same construction and operations phases of wind development, land lease payments where projects are located, property taxes or property payments in lieu of taxes paid to local governments, various forms of secondary spending that might occur from

those who benefit from wind, whether those are employed in the sector or governments that receive tax revenue from wind plants.

Of course it's important also to acknowledge local spillovers: wind development in one county or one community may impact income not only in that community but also in neighboring communities or counties. And finally, and importantly, I think it's also important to note and acknowledge the possible offsetting impacts. So for example, wind will displace some other energy source.

That will presumably result in lost jobs in that particular sector. Similarly, if wind energy increases energy prices—which it may or may not—but if it were to increase prices, then there may be lost jobs through other sectors of the economy as well. So accounting for net effects becomes really important if you want to convey an accurate aggregate story of the net impact of wind energy development on local economies.

So to evaluate a subset of those impacts, the impacts I just described, previous estimates of again local or county impacts have most often relied on two methods. First, project-level case studies, where through surveys of developers and others one seeks to estimate the gross direct, indirect and induced impacts of actual wind power plants in the past. The kind of work that Cai just described is similar to that. And secondly input/output model estimates similar to the NREL JEDI model where you're estimating potential direct, indirect and induced impacts from either individual planned or completed wind projects or alternatively an aggregate amount of assumed wind development activity.

The table on this slide presents a summary of results from the past literature and specifically input/output model estimates of county-level impacts during

the operations phase of wind power development. And I'll be comparing and contrasting the numbers presented in this table with the results of our study at the end of the presentation. But you can see here that the absentee-owned projects—that would be the standard form of wind project—for absentee-owned projects and during the operations phase employment impacts based on the input/output literature of 0.1 to 0.6 jobs per megawatt and annual earnings impacts of $5000 to $18,000 per megawatt. Again, these are county-level local impacts as described in the existing input/output literature.

Okay, so notwithstanding that existing literature some folks have identified some possible limitations to the two historically primary means by which local economic development impacts have been estimated. First, both methods, whether project-level case studies or input/output estimates, at least when applied on the local level, typically focus on gross impacts. They typically do not do a full net impact analysis with some exceptions.

Second, for project-level case studies there might be some relying on self-reported data from wind developers, there might be some concern about the focus on really just direct impacts while not paying too much attention to indirect or induced impacts, there may be concerns about the representativeness of the case studies and as well the fact that the results may not be presented consistently from one case study to the next.

And then finally with respect to input/output methods questions have sometimes been raised about sort of the applicability of some of the assumptions required when generating those estimates. And while tools like JEDI seek to address those possible limitations, there may still be some questions about if input/output estimate impacts really comport with reality. So I'm not trying to disparage either of those two approaches. They both have very important roles to play as I'll describe on the next slide. But I think it's

also important to recognize that there is a literature out there that throws some water on those methods and one of the purposes of our study was to seek to validate or at least to loosely validate the numbers that we've been seeing from these two historical methods that have been applied.

Okay, so as I noted earlier, our study used a third method to try to quantify county-level economic impacts and in particular an econometric or statistical approach to identifying the impacts of past wind power developments in the U.S. Again, I'll be describing the details of our methods at least at some level of detail a little later in the presentation. Some of the advantages or possible advantages of our approach are included in this slide. We need not apply the same set of assumptions that are required by input/output model estimates.

We can base our estimates on a large and ideally representative of actual wind power projects across a large region of the U.S., we don't need to focus on any individual plant or area. We're able to capture direct, indirect, and induced impacts and in fact not only are we allowed to but we almost have to account for really the complete set of impacts, including substitution displacement on all of the net effects that were highlighted in an earlier slide. And then ultimately in the end we can, to some degree, benchmark our findings with input/output model estimates and therefore kind of loosely test the accuracy of those methods.

I also want to acknowledge that there very clearly disadvantages with the approach that we applied and the results of which you are soon to see. First, we are not able to address net effects on a state or national scale. Our emphasis is really on county-level impacts as observed in the data that we analyzed. Secondly, we're really forced to focus on past impacts or, alternately, forecasting future impacts based on observed past events.

And then finally the results, as you'll see in a moment, in the end estimate an average impact over many counties. It's not specific to any individual project or any individual county. And so though they can certainly be helpful in benchmarking the results of other studies, our methods don't really replace the need for an input/output model or a case study-based approach if your focus is on individual counties or individual facilities.

Okay. So with that rather lengthy lead-up, what exactly did we do and what did we find? Well, as shown on this particular slide, somewhat grainy graphic on the side—sorry about that—our analysis focused on a large 12 state region of the country in the Great Plains and Rocky Mountain regions of the country. That's the highlighted yellow portion of the country as shown in the figure here. And we specifically included in our analysis 1,009 counties—basically all of the counties in that yellow area—including 130 of which that have wind power capacity additions that occurred over the timeframe of focus in our study, namely between the year 2000 and 2008.

So the blue squares that reside in the yellow area represent those counties that saw wind development during the 2000-2008 timeframe. So that's the area of the country that we studied, obviously an area with enormous wind resource potential and also an area with a substantial fraction of all the wind development that's occurred nation-wide over the last number of years.

So with that study region what we were really seeking to do is we were seeking to explain statistically changes from the year 2000 to the year 2008 in county-level annual personal income and county-level employment. And we hypothesized that changes in county-level income and employment—again from the years 2000 to 2008—might be affected by of course the amount of wind power capacity that's added in the county over that period of time as well, potentially, as the impact of changes in wind power capacity in

neighboring counties to the extent that there is spillover effects from one county to the next. But of course changes in county-level income from 2000 to 2008 might also by driven by a whole wide range of socio-economic and demographic characteristics and so we tried to control in our statistical models for those other characteristics.

So again we fed into the model not only the actual amount in megawatt terms of wind power capacity added in each county in our study region from the year 2000 to 2008—that's sort of the data that's presented to some degree in this figure here—but in addition to that we also included in our models a wide variety of control variables so that we could be more confident that we were really uniquely identifying the impact of wind power capacity on county-level economic development outcomes.

Some of the additional control variables that we included in our analysis are identified in this slide. I'm not going to read all of them. You can look at them in your free time if you wish, but they included things like the population level of the county and its poverty rate, population density, the shares of employment in agricultural, construction, manufacturing, and retail trade, the share of adults with various forms of degrees, and the share of the population that are constituted with children or the elderly—non-working population members. And a whole wide variety of socio-economic demographic variables that might impact income and employment at the county level.

Okay, so what finally did we find? Well, the final statistical models that we estimated are presented on this slide and as much as I would just love to go through the slide line by line with all of you I anticipate that in the interest of time and also sanity perhaps we should not do that. And so instead let me get to the bottom line. And that bottom line is that we find that each additional megawatt of wind power installed from 2000 to 2008 in the area of focused

that I identified before increased annual total county-level personal income by $11,000 per megawatt on average and increased total county-level employment by 0.5 jobs per megawatt on average.

So that is 0.5 jobs per megawatt and $11,000 per megawatt of wind in terms of the net average impact of wind at the county level. Now those effects primarily are operations period impacts, not construction period impacts but if we also look at construction period impacts comprehensively the numbers would be higher. And so these numbers largely—they don't exclusively—but they largely capture the operations period of wind power development and operation.

So to conclude, then, to our knowledge at least this really was the first study to use detailed econometric methods to measure the economic development impacts of past wind power installations on U.S. counties. There are, as I described, both advantages and disadvantages with this approach that I want to reinforce here. Regardless, we do find that at the county level on average a positive net economic development from wind. And those counties lucky enough to attract wind power additions with the level and average impact as I described it on the previous slide and as also summarized here.

Now whether those impacts are sizeable enough to have a meaningful impact on any individual county will of course depend on the characteristics of that county: how big is the county as well as the wind power capacity that is added. But regardless, the findings—I think very clearly—corroborate and support the idea that net economic development benefits of wind do occur at those counties that see wind power development.

Finally and perhaps also importantly, our econometric results are not perfectly and strictly comparable to previous economic output estimates: I've identified

some of the reasons for that in this particular slide. I think in the interest of time that I won't go through those reasons here. Suffice it to say that again the econometric results that I just presented are not a perfect apples-to-apples comparison with input/output estimates.

That notwithstanding, our estimated impact—again of on average $11,000 per megawatt and half a job per megawatt—are of a similar general magnitude to the input/output estimates that I presented earlier as it relates to operations period impacts of wind development, namely $5,000 to $18,000 per megawatt and employment gains of 0.1 to 0.6. And the fact that our estimates fall squarely in the range of previous input/output estimates I think provides some support for the continued use of well-designed input/output models such as JEDI, at least when applied at the county level which of course was where our analysis was really focused.

To close, for those of you that are interested in either more gory details or alternatively fewer gory details and simply a two-page summary of our key findings, we have both of those available. The journal article is available for those who can access it or are willing to pay a fee. A pre-print of the article is also available and then finally NREL was good enough to put together a short—hopefully pretty readable—two-page fact sheet on the work that is also available for folks with all of the links identified in this slide. And with that I will close. Thank you.

Ian Baring-Gould: Great. Thank you so much, Ryan. We only have one question, which lets me know that I failed to let everybody know how they can ask questions. We do this online and so if you go up to the top of your screen there there's a little Q and A button. Hit that Q and A button and it allows you to submit a question and then I'll read them out and we'll answer them. So the first one that we have—or the one that we have so far—is for Cai and it is, "How do you define

'total jobs created?' you gave the number of 1,079 jobs for the 250 megawatt wind farm, what does that really mean and how do you define 'jobs created?'"

Cai Steger: So that's actually a conversion of labor hours to a full-time equivalent, an FTE, so the survey methodology was to aggregate across the many different steps labor hours associated with different steps and then we converted those labor hours into jobs created.

Ian Baring-Gould: Great. Thank you very much. A number of questions in regards to whether the slides will be available and the answer is yes. All of the WPA webinars are recorded and it takes us about a week to get both the transcripts, the audio, and the slides updated on the WPA website so you can go there and look under "Webinars" and you'll find not only this one but about 100 webinars, all the ones we've done over the years. So please feel free. Again, it takes us about a week to get those all available. If you're interested in a specific copy of the slides that are editable or something please contact the author directly. And both these gentlemen, I'm sure, wouldn't have a problem with that.

There is a question about the JEDI software. JEDI has been solar, biofuels, coal and, if I remember, it's about 15 other things. The question is, "Are comparison charts and figures available?" From the Wind Powering America site there have been a number of comparisons between coal, wind, and natural gas. Those are a little bit old.

Typically right now we don't do those kind of direct comparisons, but there's nothing to say that people can't do that themselves and certainly there are examples of organizations and individuals who have used all of the JEDI or different JEDI models to do comparisons within different technologies. Do either of you two know of specific examples that someone could look at, not

only using JEDI, per se, but comparing wind to other conventional technologies?

Ryan Wiser: Yes, this is Ryan. There certainly is some literature in that area I know that Max We and (Dan Kamman) wrote a study that found its way into the Journal of Energy Policy some years ago that looked to compare the economic development impacts of renewables versus nonrenewables and there's certainly some other stuff out there as well but it's the one thing that's coming to mind immediately other than JEDI in my mind.

Ian Baring-Gould: Great. Another question for you, Ryan. "Why was it important to select a wind-rich region of the country? Would data for non-contiguous counties have worked for a similar structured model for the purpose of collecting the effects of spillover?"

Ryan Wiser: Yes. Great question. We actually did apply our model—at least the income model, I don't recall if we did it for the employment aspect, the employment aspect we did sort of later in the game—but earlier on we did develop a model for the entire U.S., or at least the entire contiguous U.S. So we included all states, or all 48 states, and all counties therein. The results were qualitatively and even quantitatively almost equivalent or at least similar to the ones I presented.

In the end we chose to stick with a contiguous region in large measure because the statistical geniuses that were involved in the project from the USDA were most comfortable focusing on region that was contiguous and also shared some common characteristics rather than moving to counties that have very different economic structures than those in the region that we selected. But again we did test it for the entire nation: the results are, at least for income, were in effect the same. And so I don't think it would change that

much if we were to select a different region or select a larger region, for that matter.

Ian Baring-Gould: Great, thank you. Another one for Ryan and this comes from John Miller. "Does the 0.5 jobs per megawatt and the $11,000 per megawatt truly imply that for a two megawatt project it would create one job and $22,000? Is it truly linear and direct in that fashion?

Ryan Wiser: Yes it is. But one thing again I want to really emphasize is that we're looking at net effects. So we're not looking necessarily at just the fellow who is operating the wind plant. We're looking at the full net effects within the county as a whole as a result of wind development in that county.

And so the income and the employment may of course be as a result of direct employment and direct income of those working in the wind energy sector, but could also result from many of the other side-effects that wind development is having on the local economy. More cash revenue to the government means that the government spends more money on roads which creates a job, for example.

In addition our models capture all of the possible negative impacts that wind might have on employment or income in a local county, were it to displace income from another energy source, for example, or were it to increase electricity rates. And so the calculations that John made there are absolutely accurate but I just want to put them in context that we're really looking at these net effects and so those numbers don't apply necessarily to specific to only folks that are employed directly in the wind sector.

Ian Baring-Gould: Great and just…

Cai Steger: If I could just very briefly…

Ian Baring-Gould: Go for it.

Cai Steger: …touch on that, largely because, you know, that kind of work is absolutely from out perspective as advocates for kind of confirming that the advocacy has a grounding in fact and, you know, anecdotally you hear a lot of this and these kind of benefits that communities that are supported by wind energy that have built projects have seen these types of benefits and Ryan's analysis and that kind of analysis just absolutely critical to putting a technical and scientific sheen on the matter.

Ian Baring-Gould: Great. A question that was kind of direct at Ryan but I think that both of you could provide some insight, and that's "Since you did these analyses, how do you think the numbers have changed kind of since the recession and due to the changes we currently see in the wind industry? People are talking about the wind industry getting 'lean and mean' by necessity? And so do you think the numbers that both of you have presented continue to be accurate given the current wind market and where you both see the wind market and wind jobs going in the future?"

Cai Steger: I can touch on only that the survey was conducted last year. That's not to say that we won't continue to see scale and earning effects that bring down the cost of wind as well you know, have some impact jobs due to improving the efficiency of the manufacturing and installation process. I can't speak to the historical, you know kind of changes over time, just that, you know, we surveyed companies to get their thoughts and that was their thinking at that time.

Ryan Wiser: Yes. And on my side, I think that with any industry that continues to mature and develop more and more efficiencies you're going to see fewer jobs per megawatt, as it were. At the same time you're going to see a lot more megawatts installed. And those two things are going to be moving in different directions and I would posit that the growth in megawatts is outweighing any plausible loss in jobs per megawatt.

And so the aggregate number of jobs certainly is still increasing but the question there is certainly correct as any industry becomes more efficient, whether it's the wind industry, the gas industry, the coal industry, or any other non-energy industry, you are going to see a fewer number of jobs per megawatt installed.

Ian Baring-Gould: Great. To both of you, certainly, there's a big difference from a community impact standpoint from a construction job versus a long-term operational job. Could either of you talk a little bit about the job impacts, the differences in those kinds of job classifications—the construction versus the long-term—how those play in these numbers and what communities could expect from during the construction phase versus during the long-term operational phase.

Cai Steger: So I could take a first stab at that. I think we had a 50/50 split in our numbers in terms of I think it was 520 or so jobs—construction jobs—would be created. And certainly those jobs can be sourced from a number of regions, not necessarily local. If you talk to a lot of the construction companies they have crews that travel. So you're not always seeing local benefit. We did highlight and at least surface you're seeing—and Ryan, I think was briefly touching on this—you do see a lot of local indirect economic benefits that can lead to indirect and induced jobs from the short-term bump in spending from when you're building these projects, from when you're constructing these projects.

There's also longer-term economic impacts from, you know, the royalty revenues and from developer's fees and those kind of things, and increased property taxes that filter their way into the local economy and can provide an induced jobs benefit, depending on how the trade-off and any negative or positive spillovers related to that.

But yes, certainly construction jobs are going to be a different type of job. You know, our study—again, it's a little bit different than what Ryan was trying to do but—you know, when you think about a wind project it—especially one of the size we're looking at—it can take so long, so many years, and there can be so many different touch points along the way that, you know, there's just a wide range of jobs. And certainly construction can make up a significant component of that, but there are a plethora of other types of jobs that are created along the way.

Ryan Wiser: Yes. You know, we really focused on the operations period impacts, partly because that's what the data allowed us to do, to be honest, but also because that is what the enduring impact is over the course of a wind project's lifetime in a local community. Input/output estimates of job impacts, at least as we report it in our study, shows construction period impacts of 0.1 to 2.6 jobs per impact. Again, these are county level, they're not total, they're over the county where they're located—which again contrast to the 0.1 to 0.6 jobs per megawatt during the operations period.

So clearly there is more significant jobs impact during construction than during operations, but of course that's a temporary impact in the local counties in which these projects are located.

Ian Baring-Gould: Great. Thank you. Two questions for Cai. The first one is "How do you get access to these articles? Are they on your website or do you have hints about that?" And then the more direct question, "How far down the analysis or the supply chain did you go in your analysis? I mean, you could down to every bearing, every relay, and so how far down that supply chain did you go? And then what elements did you leave out?"

Cai Steger: So those are great questions. First, in terms of the reports, they have a painfully long Web address, so as much as I hate to say "Resort to Google," you can type in the title of either report and I think they're the first things that show up in Google. Again, apologies, we just have a problem with lengthy Web addresses for some of the articles we publish.

In terms of how far down the supply chain we went, it's a couple of excellent questions. Certainly we put in caveats in our report for the potential for undercounting wind employment for a number of reasons why the study might undercount the total employment. You're not capturing exports, obviously, in this approach, exports of goods and services and how that's creating employment. The wind industry employs a number of workers that aren't directly related to wind farms and so they're not going to be included in our methodology.

You know, the education and training, government outreach roles et cetera. We tried to get a robust sense of the supply chain and we relied on in our surveys that we were picking the right kind of companies who would be incorporating that into their responses. We didn't therefore necessarily figure out how many jobs would be created associated with, you know, the manufacture of that ball bearing inclusion in the wind component. Rather, it was "what are the companies that would be associated with that step in the chain and what are their reported labor impacts?"

Ian Baring-Gould: Great. Thank you. Another question, I believe for you, Ryan. "Any thoughts on the representativeness of your results for California?"

Ryan Wiser: That's a good question. You know, California wasn't in our study region. I just described, however, that when we did a national analysis the results didn't move around very much. But one of the downsides of an analysis of the nature that we did is that it allows one to look at average impacts over the entire study area, whether that study area is the 12-state region that we selected or the entire U.S., which was another possibility. We didn't evaluate it just in California and so I'm not really able to respond to that question directly.

However, I think that really that one of the most important aspects of our study is that it helps loosely validate the kinds of estimates that are generated in input/output modeling tools such as JEDI. And JEDI is far better tuned to looking at individual sort of hypothetical conditions than others. And so while I'm not sure our results are fully applicable in California—certainly directionally they are, I would anticipate but the absolute magnitude of the numbers might differ—I think that JEDI offers a good useful tool in order to estimate those impacts on a more localized basis.

Ian Baring-Gould: Great. And one final question before we wrap up. Again primarily to Ryan, "To the extent that land owners receive income from every turbine installed and that energy generation stops do not need to be located within the county, doesn't the geographical scope almost guarantee the conclusion of kind of economic generation within the county?"

Ryan Wiser: Yes, I think that intuitively, you know, certainly the concept that if you bring wind to a county that it will improve economic conditions through employment and through income is an intuitive one. And so to some extend

perhaps we've simply proved the obvious. But I think it's also important to consider not just the directionality of things but also the absolute magnitude of the impacts.

And the numbers that we came up with in terms of dollars per megawatt and jobs per megawatt—again the comparison is not perfect—are squarely in the range of those estimated with input/output modeling tools. And I think in the end that that's really the key advantage of what we've done and a key contribution that we've provided.

Ian Baring-Gould: Great. Thank you so much for that and thank you everybody for holding out for a couple more minutes past the hour. Again, thank you to our two speakers. I do want to let everybody know that the WPA webinar series continues on the third Wednesday of each month at 3:00 Eastern. We haven't set the exact final webinars for February and March but we're looking at offshore wind in February and then water impacts while the west is continuing to be in a severe drought, as well as the southeast, for that matter, and so we're trying to pull together a webinar in March at the impacts of wind generation and that the power sector can have on water issues.

As I said, keep an eye out in the Wind Powering America e-newsletter for descriptions of the webinars coming up, but there will be one next third Wednesday in February. As I said earlier the webinars will be posted in about seven business days on the Wind Powering America website, so certainly go there and point anybody who wasn't able to phone into this webinar, any colleagues that you have to that location if you think they would have value in seeing it. Just to conclude again special thanks to the U.S. Department of Energy who funds the webinar series. There's contract information for WPA's Jonathan Bartlet at DOE, myself, and then Suzanne Teagen at NREL.

Also, thanks again to both Cai and Ryan for taking the time as well as the work that both of you are doing to provide this valuable information to the wind industry about the jobs and economic impacts of wind technology. So without further ado, thank you all for another good webinar and look forward to seeing you in the attendee list next month.

Thanks again and have a great new year.