



Tracking Clean Energy Progress: Where do we stand and how do we get back on track?

—Transcript of a webinar offered by the Clean Energy Solutions Center on 10 May 2012—
For more information, see the [clean energy policy trainings](#) offered by the Solutions Center.

Operator: The broadcast is now starting. All attendees are in listen only mode.

Victoria Healey: Okay. Hello, I'm Vickie Healey with the National Renewable Energy Laboratory and welcome to today's webinar hosted by the Clean Energy Solutions Center. Our focus today is on the findings of the recently released International Energy Agency's report, Tracking Clean Energy Progress.

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While we give people a few minutes to join, I'll quickly go over some of the webinar features. First, for audio, you have two options. You may listen through your computer or over your telephone. If you select the telephone option, a box on the right side will display the telephone number and audio pin you should use to dial in. We ask that you please mute your telephone or your computer before the presentations begin.

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If you would like to ask a question, again, you have two options. You may select the questions pane and type in your question or you can click on the raised hand icon and we will enable your audio speak function. If you are having difficulty viewing the materials through the webinar portal, you will find PDF copies of the presentations at cleanenergysolutions.org/training and you can follow along as our speakers present. Also, an audio recording and the presentations will be posted to the solution center training page within a few days.

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One quick note before we review the agenda. I'd like to mention that the National Renewable Energy Laboratory, where I work, is the operating agency for the Clean Energy Solutions Center.

And now, we are fortunate and honored to have three dynamic speakers presenting today. After I provide a short overview of the Clean Energy Solutions Center, Antonio Gawel and Markus Wrake will discuss findings of the IEA Tracking Clean Energy Progress

Report. Antonia is an Energy Analyst at IEA and is lead author of the report. Markus is a Senior Energy Analyst at IEA and leads the work on energy technology perspectives, which is the five chip publication on energy technology at IEA. Following their presentation, Mark Fulton, Global Head of Climate Change Investment Research at Deutsche Bank, will provide insights on how to bridge the gap to clean energy progress through investments and he will also comment on the recently published global climate change policy tracker report. Following the presentations, we will have a question and answer session with our speakers.

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Okay. This slide provides a bit of background in terms of how the Solution Center came to be. The Solution Center is an initiative of the Clean Energy Ministerial and is supported through a partnership with U. N. Energy. It was launched in April of last year and is primarily led by Australia, the United States and other CEM partners. One of the outcomes of this unique partnership is support of developing countries through enhancement of resources on policies relating to energy access, small to medium enterprises, and financing programs.

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The Solution Center has four primary goals. First, it serves as a clearing house of clean energy policy resources. It also serves to share policy best practices, data and analysis tools across countries. The Solution 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 policymakers and analysts from governments and technical organizations in all countries. But, we also strive to provide resources and engage with the private sector and civil society.

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Ask an Expert is a valuable service offered through the Solution Center. We have established a broad team of experts from around the globe who are available to provide policy advice and analysis for all countries at no cost. Some of the broad sectors covered by our experts include energy access, energy efficiency, renewable energy, clean transportation and regulations and utilities.

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The Solution Center offers a range of learning and training opportunities, like today's webinar, many developed in collaboration with our partners, such as Leonardo Energy. We also offer a broad range of training materials, including videos, presentations and curriculum and we recently launched a policy forum that includes a series of blogs on key policy topics. We encourage you to participate in these blogs by logging on and contributing to the discussion.

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The Solution Center has a vast library of technical resources and tools for policymakers. Some examples are listed here related to finance and investment, renewable energy, emerging clean energy policy topics and solar power opportunities.

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We encourage you to explore and take advantage of our resources and services, including the expert assistance, subscribe to our newsletter and participate in the webinars and policy forum. We also welcome your suggestions of additional resources we can add to the site and opportunities to partner to improve resources and services.

And now, it is my pleasure to turn over the webinar to our first two speakers from IEA, Antonia Gawel and Markus Rakes.

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Markus Wrake: Well, thanks a lot and good afternoon everybody. This is Markus Wrake, as my name is in Swedish speaking.

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And with me here, beside me, I have Antonia.

Antonia Gawel: Hi there.

Markus Wrake: And we're pleased to see, well, to see that there are so many people listening this afternoon, or morning if you're in the United States, as I see that many people are. I want to spend a bit of time today talking about a recent publication that we released at the Clean Energy Ministerial in London a few weeks ago. It's an early excerpt from the publication that you see up on the screen now called Energy Technology Perspectives. It's a book that the IEA

publishes every two years. It's a most ambitious and comprehensive project on energy technology where we look to the long term prospects of a low carbon energy system that we're framing, if you wish.

So, I'll just spend a couple of minutes giving you the backdrop and the four month ETP as we often refer to it before Antonia will give you more details on the progress tracking report that she was the lead author of.

I'm just trying to get up to the next slide here.

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There we go. So, ETP, like I said, it's the most long term outlook of the energy system that we do at the IEA, where we try and identify pathways to a low carbon, more secure and affordable energy system. We do that with a backbone of the scenario of modeling exercise, where we identify which technologies, what policies are needed to bring about that system and the changes needed to create that system that we think is more attractive than that one. We looked at what milestones are necessary to meet for different technologies, what timelines are necessary to follow and, of course, the end objective for us is to give them useable advice to policymakers today. So, although the outlook is very long-term, we do have the intentions to give short term advice to policymakers and decision makers in the industry, of course, too.

So, just a few words on ETP 2012, which is the mission that we are launching in just over a month's time. We are putting a strong emphasis this year on the short terms and this report that we're talking today is, I guess, the most visible example of that when we're trying to look at the next 10 years and what needs to happen in the next 10 years, given where we're willing to be in 40 years time. The theme in this year's publication of the energy systems and the benefits of thinking in systems rather than looking at individual technologies. So, we try and recognize and acknowledge the fact that technologies don't emerge in vacuums, but, rather, they depend on each other for development and deployment and the efficiency of the entire system will depend very much to what extent you take those and the linkages into account when you plan for the system.

We also, for the first time, looked beyond 2015, so, although our main results are for 2015, we have a section where we look at what would it take to completely eliminate emissions from any new regulativity by 2075. And the reason why we do that is that's, in

fact, where modern science tells us we need to be if we are to meet the two degree target that many countries are subscribing to if there's a long term temperature rise.

And, finally, we have a whole section on fossil fuels and CCS. Some people ask us why, you know, why a feature on fossil fuels when it's low carbon? And the reason is very simple is that, even though we are looking for very a decarbonized system in 40 years time, fossil fuels will inevitably play a major role in the energy system for a long time to come yet. So, if I looked at how can we transition away from that contrition where we are right now and what are the first steps? That's what decarbonization and a decreased reliance on fossil fuels forming *[inaudible]* in system.

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In the ETP this year, we had three main scenarios that we build the analysis around. This slide shows the emissions trajectories for those three scenarios from 1990 after 2050. We call them the fifth degree, the four degree and the two degree scenario, referring to the projective long term temperature rise that are implicit in these emissions trajectory. So, if we follow the dark blue line, as you see on the screen, we're effectively heading for a long term temperature rise of about six degrees. That's where we're heading with the current policy. So, if we're doing nothing more than we currently have in place in terms of policy, this is our estimate of where we would end up in terms of emissions. The orange – orangy-type line in the middle, the four degrees denier, is where we are likely to go if all currently announced policies were to be implemented. That's a fairly optimistic scenario in terms of what policies could deliver, I would say. But, nevertheless, that gives you an idea of where, for example, the Cancun Agreement and what came out of Copenhagen COP a few years ago, if implemented, would take it.

The main focus, however, of each of these, the lighter blue scenario, the text that's on the screen, it shows a trajectory that's consistent with what the native climate signs tells us is necessary to limit this long term temperature rise to two degrees. It's, in effect, it means that we have to, basically, cut emissions of CO₂ from a range of activities by about 50 percent in the next 50 years. And as you'll see here, that's a stark contrast to where we're heading, which is, in effect, doubling emissions over the next four decades. So, it's a fairly steep decline and a very significant challenge to achieve it.

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Now, we try and break down the analysis, as I mentioned before, focusing on technologies and we also break it down by country and by sector. And what you see here on the screen is a zooming in on two of these scenarios that I've shown on the last slide, so looking at the next 10 years after 2020, or next 8 years, I guess it is now, showing at the top, you see the emissions trajectory in the 6 degree scenario, basically, where we're heading right now; and at the bottom, you see the emissions in the 2 degree scenario, the 2DS, which is about a 30 percent reduction in emissions compared to the current policy pathway. And then the wedges represent the contribution in emissions reductions that would come from different sectors. So, this is one way of slicing the pie, if you wish, looking at the contribution by sector. You could also do, as you will see if you happen to come across a copy of ETP 2012, you'll see that we present this kind of graphics for all technology and regions also. And, of course, we go deep into details of what is actually happening in each of these sectors and what needs to be put in place in terms of policies and so forth to realize these changes. And the reason why we show this figure now, of course, is that the report that we'll talk about in a second, this is the timeframe where we're looking at. So, we're trying to compare where we need to be in 2020, looking at this slide here, in terms of technology deployment and policy development to where we are right now in 2012.

And with that, I'll turn over to my colleague, Antonia, who, again, is the lead author of this report and has just done a tremendous job together with our colleagues at the IEA northern and partner countries and organizations to pull this report together. Go ahead.

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Antonia Gawel:

Thanks, Markus, and thanks, Vickie, for the opportunity to present this report through the Clean Energy Solution Center. So, I'd like to start, in this early release report, we focused mainly on one chapter, but will be the overall lead ETP book, which looks at the more near term in terms of where we stand on clean energy technology development and deployment and whether we're on track to meeting the two degree scenario objective. And, maybe, just as a bit of background in what we did to come up with our analysis, is that we tried to look across a series of indicators to develop an assessment as to whether technologies were doing well or not. So, we looked at technology progress indicators, looking at information on technology costs, public spending on RD&V. We also looked at indicators of technology, kind of the creation of technology markets. So, looking at government policies, private sector investments. And, finally, looking at technology

deployment. So, basically, the extent to which technologies were being deployed on the ground in countries, what their shares were in the overall electricity or energy consumption as well. And when taking all of those indicators together, we effectively came up with this assessment, as you can see on this slide, which, unfortunately, doesn't necessarily look very positive in some instances. I mean, we do find that, overall, clean energy technology progress is very much falling behind in those sectors against achieving the two degree scenario goals.

I guess, on a positive note, we find that mature renewable energy technologies are doing quite well and we'll look at that in a little bit more detail in a minute. There has been some improvements in industry and transport, which we'll look at as well and, maybe, perhaps, you know, more concerning is that some of the areas of big potential for CO2 emission reductions are progressing very slowly. So, you see that energy efficiency potential is still quite large, in particular in buildings, industry and transport. And, finally, carbon capture and storage is really still in its infancy compared to where it needs to be. So, that's the major concern that we've highlighted in the report as well.

So, looking at a few of the results from the report in a little bit more detail – I'm just waiting for the slide to change.

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Okay. If we – I mean, we don't have time to go into all of the analysis and all of the results from the report, but what I'll do is just run through a few of the key findings and key messages here.

So, first, what we find is that coal continues to dominate power generation. It's been the fastest growing energy source in absolute terms and it's met nearly half of new power plant capacity globally over the past decade. I guess, to some, maybe this isn't so surprising, but I think what we did find surprising in our analysis is that over half of the new coal fired power plants being built are actually built with inefficient technology. So, sub-critical coal plants are still being built, to a large extent. And, broadly, this presents two challenges. One is that, you know, while we're not using the most efficient technologies, we're not getting the lower carbon benefits of those technologies as coal continues to grow and, at the same time, we see that carbon capture and storage technologies are, as I mentioned, falling behind. And so, there's a big issue to address here, both in terms of fossil fuel and CTS deployment.

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So, now that we've presented some of the bad news, as I mentioned, removals is probably the highest point in our analysis and that's mature renewable energy technologies are actually deploying very well. We find that a portfolio of renewables, which includes hydropower, biomass, wind, solar PV, has progressed very well over the past decade and are on track to meet the two degree scenario objectives. As we look at wind, we find that there are 27 percent average annual growth rates. Solar PV has seen 42 average annual percent growth rates. And also, system costs have reduced enormously. So, again, taking solar PV as an example, in some countries in just three years, we've seen those system costs decrease by up to 75 percent. And this has been supported largely by strong policy in a lot of those countries as well.

Now, I guess, the challenge is to maintain those rates of progress. We do still need enhanced research developments and demonstration to insure that some of the more less dense renewable technologies come to market. So, that looks at concentrated solar power, offshore wind, but we also need to see these more mature renewable technologies, like solar PV and onshore wind deployed to more countries of high resource potential to maintain current growth rate. So, again, it's a positive picture for renewables and I think we just encourage that that progress continues.

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Yeah. So, now, moving to the transport sector, just again, to present a few examples. You know, another positive message on one hand is that we do find that some of the easiest things to do will offer the greatest benefit over the next decade. So, fuel economy. So, basically, decreasing the energy, the gasoline consumption per kilometer is a very easy solution to reducing CO2 emissions within the transport sector. We find that there has been positive progress in this area over the past few years. So, basically, between 2005 and 2008, we've seen a 1.7 percent annual improvement in fuel economy. This is positive, but it's not quite enough to meet the two degree scenario objective. We see that we need a 2.7 percent average annual reduction.

Now, what you see in this slide represents some of the improvements that have taken place in a number of different countries, but also the standards in place to help reduce – to improve fuel economy further. And, I guess, the main point here really is that standards can help and then, supporting policies to

help consumers make the right decisions in terms of the vehicles that they purchase will also be very important tools to make this happen. Again, what's somewhat surprising, though, is that outside the OACB, we find that very few countries actually have fuel economy standards in place for light duty vehicles. And for trucks, standards are now only emerging within the United States and Japan. So, there's huge room for improvement there, but a very significant area of potential as well.

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So, now moving to another transport example with electric vehicles, so this is where we see that, you know, governments do have very ambitious goals and the challenge that we see, while this is positive, is that meeting these goals will require significant policy action. You can see here that governments have set targets to achieve 20 million electric vehicles on the road by 2020; and the gap that you see, so the bar charts on the bottom, represents what we find to be industry announcements and commitments to production levels. So, basically, after 2014, announced manufacturer targets are less certain and certainly less predictable. I think that, you know, we want to emphasize that, you know, beyond 2014, from any of the perspectives, it was a very, very long way to look out, but it's something that is worth keeping an eye on as to, you know, how these announcements continue to grow and whether they continue to be on track with government targets and expectations.

So, another slightly different example, which presents a similar challenge, is also nuclear energy. So, in our analysis, we did find that following the Cooper *[inaudible]* accident, some governments have starting stating intention to phase out or decrease their dependence on nuclear energy. So, that includes Switzerland, Belgium, Germany and Japan, for example. But, most governments continue to maintain emissions targets and by 2025, we see that announced plans would see nuclear capacity increase by almost 50 percent. So, again, this is an ambitious goal, but we do see that achieving this will be challenging, given recent difficulties related to public opposition to nuclear power. So, this really just illustrates that, in this example for nuclear and electric vehicles, our analysis finds very strong and positive goals set by governments, but making those goals reality will still require quite a significant push from a policy perspective.

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So, illustrating just, yet, another example –

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– from a different sector industry –

[Laughter]

– this could give a sort of broad, macroeconomic overview. You know, we see here that energy efficiency is pretty – it's very essential and it has been improving. Between 1990 and 2009, the graph here shows that energy intensity has decreased by an average of about two percent per year. Now, this is positive, but energy intensity, is the global economy needs to fall by another two-thirds by 2050 to achieve the two degree scenario goal. So, again, we do find positive progress, but it's not quite enough, unfortunately. And so, what we need to see is a 2.4 average annual improvement, as opposed to the two percent that we've seen up until today over the past decade.

So, just to highlight here that the world's energy efficiency is essential and I think that, probably, most of us continue to press for energy efficiency improvements and it does have economic benefits. But, at the same time, it is an area where there remains to be significant untapped potential. And maybe just one thing to point out and highlight in this graph because it can be a little bit confusing. You know, we see that energy intensity of the economy is improving, but just to mention that this shouldn't be confused with energy efficiency in the industry sector. You know, there can be changes and structures of economies and fluctuations in the material's prices, which have an impact on the energy intensity, which doesn't necessarily show up in these types of graphs. But, just to mention it, you know, we do also find that the actual energy efficiency in the industry sector has improved as well.

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So, finally, as in the last snapshot of this analysis, and I'm sure that Mark will probably talk to some of these issues also, is the question of the investment. And, actually, this is the one that people are most concerned about these days is how much is all of this going to cost? You know, given limited capital, if I have a choice, you know, where am I gonna put my money and why should I invest in clean energy technologies? So, we do have in this earlier release report done by a colleague of mine, Cecelia Tam, a section on financing clean energy technology, and we will have a larger section in ETP 2012, but, broadly speaking, what this

finds is that capital is available, but the right investment framework is still required to help shift the capital from fossil fuel to clean energy investments.

So, basically, what this graph shows is that, in the near term, so between now and 2020, the scale of additional investment required over the next decade amounts to about \$5 trillion U. S. But, at the same time, we find that fuel savings amounts to about \$4 trillion U. S. In the longer term, however, you can't see it here, but out to 2060, we find that the fuel savings actually outweigh the additional investment required. So, over the longer term, we do see a net benefit from the clean energy transition. And, I guess, a point to mention, again, is that investment share are not the same thing as cost. So, you know, when we talk about investments versus fuel savings, we try to look at it from a balanced perspective in that we look at the net benefit of what this can bring from an economic perspective.

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So, I think that that really sums up the main – some of the key highlights from the report. As I mentioned, there's many more details and many – much more information in the actual contents of the report itself and we're happy to talk about that in more detail. But, just to, lastly, highlight what we included as key recommendations, really, during the Clean Energy Ministerial a few weeks ago, you know we have, as Mark has mentioned, a lot of technology specific and cost cutting recommendations. But, here, really, at the basic level, we see three key things that are required to try to at least help us get back on track.

First, we recommend that energy prices should reflect the true cost of energy. So, basically, accounting for the positive and negative impacts of energy production and consumption.

Second, as I mentioned, we should unlock the potential of energy efficiency and I think this is something that the IEA and many organizations, you know, continue to press and we continue to see slower progress than we would hope to see in this area. But, it is really an area with huge potential.

And, finally, to accelerate energy innovation and public support for research developments and demonstrations and believe the key reason for this is to help lay the groundwork, really, for the private sector to come in and innovate and take these technologies to market.

So, that's really the crux of the report and the main highlights, I guess you could say, of its content. I think, you know, there are many experts on the line and I'm sure that many of you have done your own analysis and have your own thoughts and recommendations of this sort. So, we look forward to hearing from you and during, also, feedback or questions that you have on our work here.

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And then, finally, I'll just toss back to Markus for the last comment.

Markus Wrake: Yes, and thanks, Antonia. I just will add that this report that we're talking about, you can download it free of charge from the IEA website right now. So, it's just go to our website and find it there. And then, a month from now, we're gonna release the full publication, ETP 2012. You'll find much more information about that on our web post as well. So, with that, I look forward to a fruitful discussion over the next half hour and over to Mark.

Mark Fulton: Well, thanks Antonia and Markus.

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So, we – I'm gonna talk about some, briefly, some findings from a paper we recently published called Global Climate Change Policy Tracker.

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This document is available on our website, which you see here, dbcca.com/research. But, I'm now gonna just quickly run through some of the main thoughts here and this is gonna be something of a focus now on the policy angle in terms of what is policy, in a sense, look like, what it can achieve and how well is it set up in order for these large areas to achieve it? So, that gives us both the notion of, again, something like can we get to anywhere near where we want to go. But, most importantly, is that the sort of – are we gonna get there because investors are gonna be excited about the opportunities because of the policy regimes or not? And, as a result of that, you know, what market success for investors and then, how that might play out, as opposed to not reaching where we might wanna go.

So, on the first slide, if you could bring that up.

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This is an approach we use. We do some slightly, I think, slightly unique, where we actually use, we model all the mandates and emission targets from around the world that we can find at Columbia University's Earth Center, then models the impact of those in terms of carbon abatement. Now, while we're on a mission target that's fairly well done, I think our bottom up mandate modeling is a bit unusual. As I say, we haven't seen so much of that. So, what we try and do is look at – and why do mandates count? Obvious that emission targets are like an expression of will and, unless you've got a very powerful carbon market tied to an emissions target, that's not necessarily gonna deliver. It's just an expression of "This is where I'd like to go"; whereas, many of the mandates are potentially more enforceable and they're more specific by sector. And then, for investors, they have specific implications sector by sector. So, we like to look at what the mandates also are likely to try and achieve and then, look at the best divider of those. We call it the maximum potential country by country. So, if everything worked, I'd either have a mandate and some of the mandates add up to more than the emissions targets, particularly in Europe where we have this hot air problem, an emissions target, i.e., that they set them – they set the baselines really rather easy to achieve. And, in fact, the mandates they then impose were more strict than their emissions target. So, we like to look at, if you counted the maximum of all that, how far could you go? And that's what these charts here do. They show, you know, where we're starting from the BAU emissions are forecasted by 2020, there's gonna be 61 gigatons, roughly, unless something's done. Emissions targets on their own would bring that down to 53.5. The mandates do somewhat better at 52.3 and the maximum of all of them is 49.8. So, the very best the world could achieve on what it's announced, as far as we can see is a 6, a 5.8 gigaton gap and it's gonna have at least a 9.5 gigaton gap if it's not careful. And it could be a lot worse than that if any of these policies are simply, you know, they don't achieve that much.

So, you know, we know that there's a big task on here at the climate level. But, the other point, again, for investors is these mandates are very important. The question is will the mandate drive the investment?

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If you look at the next page, we just – I just want to point out something about the development that, in terms of timing, you'll notice that the BAU line, which is the top blue line, sort of peaks.

Its growth rate peaks in 2016. Well, that's very simply because we assumed, as I think a lot of people will, that some time over this decade the emerging market growth rate, particular, like, in China, will start to sort of plateau out and not grow quite as quickly. And that's really what drives the bottom, sort of, semi-yellow line to actually form a peak in 2016 in terms of the admissions after all maximum potential if it's achieved. So, it's not just the question of, yeah, you know, you get a peak and emissions if everyone does what they think – they say they're gonna do or trying to do and it's 100 percent successful. And, let's face it, that's pretty wishful thinking. But, even then, we wouldn't get a peak if you didn't get the growth rates in emerging markets to start slowing down. So, as emerging markets just keep growing, China just grows, you know, forever at 8 to 10 percent, then, you know, it looks very, very challenging, indeed, for the world's climate as I think we heard from Markus. It's going to be extremely difficult to get anywhere near a 450 part per million outcome. And so, getting to these emission targets is very important, mandates that is.

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On the next page, we just look to the history, though, to decide, you know, have policymakers, are they still trying or have they really, sort of, given up? Because when it comes to investors, they often, you know, investment sentiment can be quite affected by the perception of whether, you know, the international process is still working. You know, where the peak governments have sort of committed. And one way you look for commitments is are their policies moving, you know, in the right direction? Well, what Columbia did for us here is we sort of looked to the history of when we produced our document, going back to a pre-Copenhagen number in October, 2009. And what you can see there is, obviously, Copenhagen, for all of it's, sort of, failure at the, sort of, the total climate change deal, did produce through the Copenhagen accord and the commitment, a substantial increase in – a decrease in the emissions gap, as measured by the maximum potential as people made commitments, both mandates and emissions targets. That sort of continued to improve a little bit, but then it really, in the last year, which might be a little surprising, improved a fair bit. So, people might say, "Oh, goodness, no. I thought things weren't going so well." Well, basically, that's the care of the Chinese five year plan over the last year that really moved the dial down from that 7.3 gigaton gap to the 5.8 gigaton gap. So, really, you know, China is, you know, is the big elephant in the room. It's the big emitter and what the Chinese do is going to be heavily – gonna determine the overall outcomes in many senses. And their continued movement is helpful.

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And, indeed, if you look at the next page, when we look at these sorts of what's driving this and we're going to do a follow up paper in the next couple of weeks where we actually split out energy efficiency targets from renewable targets from other – or mandates, it is, indeed, true that the biggest single abatement target out there is the Chinese energy intensity target. It is massive in terms of its impact, 3.4 gigatons by 2020. So, getting China to get more energy efficiency, energy intensity, is like the number one priority, it would appear, in terms of climate targets. So, there's gonna be huge investment opportunities, we presume, as China pushes aggressively on its energy intensity. Interestingly, in Brazil, it's the next cab off the rank because that's with the deforestation mandate. So, again, that has implications for what's going on in the Brazilian economy. In the United States, you might argue, "Can we really put the 17 percent administration, sort of a, so-called target as a target?" We decided to be kind and say it was a target, but there's a debate as to how enforceable that is. Then, you get the Indonesians, again, which is gonna be very forestry dependent. You get the first renewable target, which is in Europe, as a big driver. Then, you get energy efficiency in Russia and energy efficiency in Europe. And then, you get the Chinese wind. And then, again, you get another European efficiency measure. So, what is interesting to us is to realize just how important the mandate level - I mean, you heard our colleagues at the IEA saying just energy efficiency is critical. There's no doubt and governments know that and a lot of their abatement targets rest on efficiency and, therefore, for investors, continuing to pursue efficiency options, we think, is not only economic, we believe, and more economic than many of the other ideas out there, but it's also heavily supported by government, sometimes in mandates, sometimes in just wishful thinking, but it's certainly out there.

Just, again, before I go to specific policy regimes, just on the next chart –

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I just finish up and say, you know, we talk about, you know, China is driving the good news in terms of policy moving ahead. But, I want to say, again, it certainly needs to because BAU in China, we estimate to be 16 gigatons of emissions, which is more than the U. S. and Europe combined. So, there's no doubt that they certainly need to be making this big move to reduce emissions. And you can see that U. S. and Europe are moving in the right direction, but their actual impact, compared to China, is really not that significant

and that is partly to do with the fact that, you know, they are actually the much more efficient stage in terms of their – for what they're doing with the share of GDP in many senses and they can only push so much further.

Now, one thing I will say in this figure in the United States, this does not assume a major coal to gas switch, which we actually believe, but Columbia's not modeled. But, that coal to gas switch could improve the U. S. numbers significantly, but it's obviously not a policy drive, it's an economic push, although you could argue that the EPA's policy in relation to coal is going to also constrain coal and make a lot more retirement of coal plants. So, I think the coal to gas switch is an important element in the United States, which isn't really showing up here.

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So, on the next two pages, we show what we call our best in class policy table. And this focuses on the big Clean Energy Ministerial countries. And these are a set of standards that we've – or policy regimes that we've looked at over the past two or three years, which lead us to feel where you've got strong policy in a particular country and how that might help, then, either achieve targets and lead to investment opportunities. Germany and China stand out to us in terms of their policy regimes and their ability to maintain those because their deficits are not a major problem constraining them. United Kingdom has recently, in our – has received a bit of a red signal in feed-in tariffs and, obviously, with its budget constraint, needs to work very hard to make sure that it can maintain its policy regime, but it still remains fairly solid. But, the Nordic countries tend to be pretty strong. Australia has improved given its carbon markets and its state level policies. Japan is looking good for us in terms of renewables and energy efficiency, but, of course, faces its whole overall issue when it comes to nuclear in terms of meeting its targets. And we think both the U. K. and Australia may be a bit challenged to meet their targets because they're starting from such low bases. But, they do have good, investable, sort of, policy regimes in our view.

And then, you get into many of the other European countries, which have different issues facing them to do their feed-in tariff, whether they can maintain the course, how much their advising. And then, we get down into, sort of, many more countries, which are more challenged.

[Next Slide]

Now, the United States tends to be challenged at a policy level, at the federal level, on the next page here, as you can see. And that really reflects the on/off nature of U. S. incentives, which I'm sure I don't need to tell everyone about who's listening to this. But, nevertheless, it's uncertain as to how many of the current – you know, how many of current federal incentives will survive in the next two years. Some of them already sunset. So, you do rely on a lot of state level and you do rely on the RPSs. We've been doing a lot of work on the RPSs and if the U. S. has got anything going, but it's still gonna be the state level RPSs. So, that remains a problem. So, when you look at our, sort of, traffic light in terms of ability of countries to reach what they've announced, then, you know, the maximum potential, even though it falls short, doesn't look like it, what we've met anyway. So, again, from a climate perspective and climate tracking, indeed, a 450 parts does look very challenging and, therefore, if you believe the climate science, in the long run, this pushes you more toward adaptation investment because we're gonna have to adapt. But, nevertheless, in the mitigation world, there are still a lot of very big countries where it looks like they have got solid regimes, they are investable and they are moving ahead. But, energy efficiency does remain a very, very strong theme in our view for investors. So, I might pass back there. Hello?

Victoria Healey: Okay, thank you. Hi, I'm back. I'm sorry. I was working the phones. So, again, this is Vickie Healey with the National Renewable Energy Laboratory and I just want to thank Antonia, Markus and Mark for their outstanding presentations. They've definitely provided us with a lot of valuable information today.

So, now, with the time remaining, we'd like to ask a few questions posed by our audience to the panelists if you're ready to go with that.

Antonia Gawel: Yep.

Victoria Healey: Okay, great. First, we – Ale – Alejandro Core has their hand raised, so we're gonna open up the mic to Alejandro to ask a question. So, give us just a second. Ready?

Male: It should be open.

Victoria Healey: Alejandro, are you on the line?

Participant: Hello?

Male: Yeah.

Victoria Healey: Hello. Hi. You had a question. You had your hand raised.

Participant: Yes. Yes. It's, in the first part of the explanation, you consider it as different energy scenarios for the IEA report, different issues, but not the implication of the shale gas movement, yes? I believe that the shale gas movement will include a lot of offsets and the switching of technologies from coal, inefficient coal fired plants to a gas fired plant. Could you enter in detail about your assumptions, please?

Antonia Gawel: Go ahead.

Markus Wrake: Yeah, this is Markus here from the IEA. Thanks. That's an excellent question. Well, we do take –

[New Slide]

– the shale gas –

[New Slide]

– the development and the gas extraction business into account.

[New Slide]

[Inaudible] in that we—

[New Slide]

—in our analysis, sort of the assumptions around prices are cause – driving those results. So, you know, one thing that's changed a lot in this year's ETP, if you look at the framework assumptions, are, in fact, the price projections for natural gas, which, of course is driven, therefore, driven by a lot of what we've seen in the shale gas and unconventional gas, in general, in that area. So, we do see a lot more gas coming into the system and, in fact, we have a whole chapter in ETP 2012 dedicated to the evolution of the gas, of natural gas technologies and gas markets. So, you will see that we spend a lot of time talking about the transition and what it – and the transition low carbon system and what role gas could play there because all those, *[inaudible]* in the short-term natural gas is very attractive, not only from an economic standpoint, but also from the climate change perspective. At some point in time, gas will go from being part of the solution to part of the problem and will be a relatively high carbon and not more than a few decades. So, you're right that this is a major factor and we could probably spend a whole afternoon talking about it. But, we do take it into account as best as we can. So, over to you, Vickie.

Victoria Healey: Oh, great. Thank you. And we have another raised hand. I believe the pronunciation of this name is Lopedeis [*spelling unknown*] . So, we'll open up the mic [*inaudible*].

Participant: My name is [*inaudible*].

Victoria Healey: Rock. Okay, thank you for that. Thank you.

Participant: [*Audio Skip*].

Victoria Healey: So, Rock, do you have a question?

[*Audio Skip*]

Victoria Healey: Oh.

Participant: Yes, please. [*Audio Skip*] the reduction of costs in the [*Audio Skip*] higher than they are right now. As you mentioned, the recent [*Audio Skip*] the change in the model or anything.

Victoria Healey: Rock?

Male: Rock, I—do you want to—

Victoria Healey: Okay. Rock, this is Vickie again. We weren't able to – your phone was breaking up pretty badly. I was wondering if I could ask you to type in your question so I can present it over to the speakers and they can address it?

Male: Go ahead. Repeat the question.

Victoria Healey: Okay. So, if you could do that, that would be terrific. In the meantime, we have several questions that have been typed in and one of the questions, this would be for Markus and Antonia. In which countries and what PV materials have there been 75 percent improvements as you mentioned in your slide?

Antonia Gawel: Thanks, Vickie. This is Antonia speaking. Basically, what we find is that in a few of the European markets, there have been very rapid improvements in the capacity cost of solar PV for the same would be an example. If we take the – if you look at the overall cost of modules, solar PV modules, kind of a – if you take a global average of the cost of solar PV modules over the past decade, global module cost has decreased for – by about 75 percent. But, it is in some of those European countries where, over the past years, there has been that rate of reduction in such a short timeframe. Sorry. Back to you.

Victoria Healey: Thanks. Okay. Thank you. And then, Rock has typed in his question and the question is, regarding PV costs, has IEA taken into account the fact that current costs are lower than those assumed by IEA for 2030?

Markus Wrake: Sorry. Can you repeat that, please, Vickie?

Victoria Healey: Oh, sure. Let's see. Regarding PV costs, has IEA taken into account the fact that current costs are lower than those assume by IEA for 2030? And he states by a large margin.

Markus Wrake: I'm not entirely sure I understand the question, but our numbers here are the latest assessments that we've done. So, if we have been quoted as having much higher costs than other publications, that's problematic for us, of course. Then, if we had published other results earlier, that's certainly possible, but these are the latest analysis and the latest results that we have.

Victoria Healey: Okay.

Antonia Gawel: Yeah, I guess, maybe just to add that, I mean, one of the challenges is that, especially in terms of renewable technologies, the costs have been changing so incredibly rapidly over the past even year or two, as we mentioned. So, as Markus mentioned, in the ETP 2012, the models, the costs that are in there at the moment, are the most recent costs that we have and then, projected out to 2020 with associated learning rates; which, we'll see those costs continue to come down in that timeframe. So, one of the challenges, I guess, in all of these exercises is that year on year, the costs are evolving and evolving very quickly for some technologies. So, in every new publication, we try to keep on top of all the current developments in the market. But, those might be out. I mean, anything that was quoted a year ago might already be out to date today. So, it's, hopefully, yes, this is close in line with current costs.

Victoria Healey: Great. Thank you. We have a question from David Rogers. He asks, regarding energy efficiency, please share your perspective on the sustainable energy for all goals to double the rate of efficiency improvement. And what is the current rate and what is the rate that ETP says is needed?

Antonia Gawel: You can say it.

[Laughter]

Okay. Sorry. Markus and I are deliberating over who answers.

[Laughter]

I guess, I can start. I mean, I guess, I mean, I would generally say that we certainly purport the SE for all objectives. I guess, they have three, kind of, overall goals that they've set to achieve and in energy efficiency, that's certainly something that said that we would push for as well. In terms of ETP, what we've highlighted is a need to improve energy intensity by 2.4 percent over the coming four decades – annual improvement of 2.4 percent. And, I guess, as I mentioned, what we have seen is the rate of about two percent, so there has been improvements to achieve those objectives.

Basically, more, you know, a more rapid improvement needs to be seen. And, again, in ETP 2012, while we don't – because it focuses very much on sectors and the contributions that different sectors can make, so, for example, buildings, industry, power generation and so on, in each of those sectors, we look at the contributions that can be made through energy efficiency improvements. And, in particular, we find that a huge – again, big areas of potential are, indeed, in the building sector. That still needs to be addressed and, also, in industry and you will see – you'll see a more detailed look in each of the different industry sectors as to the potential that can be achieved for improvements in energy efficiency in the industry sector. *[Inaudible]*. I'll pass it to Markus here.

Markus Wrake:

And just a general reflection, again, on the importance there. We, you know, as Antonia mentioned, the picture in energy intensity is not so bad looking over the last 20 years, but it's more so true that if you go back a bit further, the improvement and the intensity has improved about one percent per year and it's actually slowed over – the improvement rate has slowed over the last couple of years. So, but this will be one of the major challenges. And we have quite a significant decoupling of economic growth from energy use in our scenario. So, there is a lot of efficiency improvement in our scenarios that needs to be realized through quality action and this is not going to be beneficial.

Mark Fulton:

It's Mark Fulton. Perhaps, I could add from an investing perspective, again, because I was talking about it from that perspective, is that we think that the many corporations now really get the point that in hard economic times, efficiency means a better bottom line. And, you know, I just think that is becoming a more and more of a focus, particularly for the large corporations who want to participate in sustainability push anyway. So, we're seeing much more attention to that. Then, the question comes back to the payback horizon. You know, some of these efficiency projects don't often satisfy the very fast paybacks that some companies demand. So, it's a question of whether the boards are prepared to start seeing a little bit of a longer term perspective there at the industrial efficiency level. But, I think that's promising.

And then, on buildings, we've been doing a lot of work on financing models for buildings. And we do think that there's going to be another big push to get the financing models, you know, more widely accepted, whether they be in need of policy support, such as pace programs or they're going to be some of these new emerging managed energy service agreement type structures that we find particularly interesting. So, I think the good news is that the corporate and finance sector really gets the energy efficiency opportunity and is doing its best to find good returns there.

Victoria Healey: Great. Thanks everyone. I have another hand raised. I actually have a couple of hands raised. We'd like to open the mic to Irena Lazarini [*spelling unknown*]. Irena, are you on the line? Hello?

[*Inaudible*]

Victoria Healey: Okay.

Male: We'll come back.

Victoria Healey: We'll come back and try again. In the meantime, Olga Debravidova [*spelling unknown*]. Apologies for that pronunciation. Olga, we're opening the mic to you.

Participant: Yes, thank you. Can you hear me?

Victoria Healey: Yes.

Male: Yeah.

Participant: Okay. Great. This is a question for Mark Fulton, I guess. I'm looking at the table you showed in your presentation and it looks like, of all the countries I know, as Russia, is actually least likely to achieve its clean energy target or energy efficiency target. If that is true, I think the apparent problem is that we don't have any means of financial support for the surrogate. Would you say that there are any instruments that are more, you know, of a more priority, of a higher priority, to us? What would be your – what's your – I'm sorry. What would your recommendations be for us? You know, where should we start? Thank you.

Mark Fulton: Well, I'm gonna admit that I'm not much of a Russian expert.

[*Laughter*]

I just have to admit that. And maybe that's because, you know, sometimes, when you look at situations that look highly complex and not much happening, the investors, this is the point. Investors

immediately go left to hide what's next, and I'm just being brutal about that. So, you know, sometimes, getting started if things are really not obvious is a bit of a struggle. But, I'm quite sure the IEA has got some fabulous roadmaps that they've got sorted out for you. But, I supposed the simple point being is that, to me, it's always the question of, you know, what are the most successful set of proven either renewable energy, you know, approaches from, you know, sort of the new renewable targets backed up by feed in tariffs or cash grants or reversed auctions with strong PPAs that come out of them. I mean, you know, if you're serious about renewables, then until they reach great parity, they need some sort of incentive structure. And that'd be the first point.

I think the second point on energy efficiency is that when industry, you know, when there's lots of energy efficiency that isn't taking place and the investment markets are not as advanced in thinking about getting those, and there is a question again about potential policy interventions to encourage, you know, the low hanging fruit to be taken. So, again, without being an expert, it would appear that just policy regime, you know, isn't – just doesn't look like it's, you know, that robust to us. But, I'd love to hear the IEA's view on that too.

Antonia Gawel: Well, we didn't – I mean, I guess we didn't hear the question 100 percent. I guess if we understood correctly, it was related to Russia's achieving of the energy – of their energy efficiency targets. Is that correct?

Mark Fulton: I think it was all targets and us, you know, we score them as weak across the board, generally. So, it's a question of how does Russia get to achieving, you know, any of its targets in a way.

Markus Wrake: Well, it's a difficult question, I think, to answer. It's true that, while we look at Russia in ETP, we have a chapter on Russia, there is certainly a large gap between where they need to go and where they're heading. There's probably a relatively larger gap there than any other country. But, outside of that, they have a huge potential in the efficiency area. Just to mention one number that we published last year from the IEA, if Russia were to go to the same kind of efficiency in their gap net worth as the old – the average, by 2030, the savings every year will equal their current exports. And that's just the savings that they could realize in the gap, I feel. So, I mean, that shows some of the potential and also how little is being done. But, I think that's a topic for a longer discussion than just now.

Victoria Healey: Great. Thanks everyone. And just, real quick, we'll try to check in with Irena Lazarini again to see if she's on the line for a question.

Participant: Yes, I am. Hello?

Victoria Healey: Hi.

Participant: Hello. Good afternoon, everybody. Yeah, sorry. I have one question for Mark Fulton and my question is the following. You were mentioning that China's having the good news and it might be linked to the five year plan, which is very encouraging. But, is really China perceived by the investors as an example of civility because, see, there's a very delicate and political moment for China, as you may know. With the change of the guards, we don't really know where China will be heading and the new leaders will keep the promise of social *[inaudible]* of environmental energy policies. Thank you.

Mark Fulton: Well, that's a very good question, which, you know, which investors always have in the back of their mind in one sense. You know, we do have some – definitely have joint ventures in China ourselves and we're working on some. And we believe that it is definitely possible to work business in China. And, you know, you have to, you know, we're certainly of view that China continues to be a place where both international investors will, with the appropriate structures, try to do business. I think the question is whether – how big those – in fact, it's not so much, I suspect, whether the international investor wants to participate, but whether they actually – there's that much room for them given the size of the Chinese state banks and how powerful they are and how low their cost to capital is at times. So, you know, the question is how much international capital is really going to close with China? I actually think it will want to, barring something very unusual happening. And I think people do want to work with that environment. But, you know, it is challenging sometimes. But, I think the question is how open is China to that influence? Does it really need it or want it? In other words, will China simply, mostly finance its own target, you know, internally and grow it internally or will it continue to reach out and do joint ventures, in particular, and encourage international investors and corporations to join them? Hopefully, it will and that will continue. So, I remain optimistic on that huge and most important market.

Victoria Healey: Thanks, Mark. And, also, I'd just like to remind everyone, if you can mute your phones and computers. We're getting a lot of background noise right now. And, Mark, I have a little – a bit of a follow up question to that from Andrea Tuttle. And Andrea asks,

the Deutsche Bank findings implies investors will be attracted to China. Is China interested in engaging with outside investors or do they prefer domestic investors?

Mark Fulton: Which I think I – you know, that'd been a great question 'cause that's exactly what I rolled into that.

Victoria Healey: Right.

Mark Fulton: So, yeah, the answer is, you know, that can be a mixed bag at times. I believe that they are and as I'd say are be active there. And I believe they will want to continue to be as they, you know, they integrate, you know, increasingly into world markets. And, yeah, I'm optimistic that they'll want to engage. But, I would admit, will the bulk of the investment come within China itself? For the next 10 years, probably, most likely. But, I think that, you know, international investors can find an important role and a useful role. And, of course, China will, ultimately, want to *[inaudible]* the technologies until they've got the ability to. We did a lot of work looking at the complementarity between the U. S. venture capital and public R & D markets like , how the U. S. focuses on the, you know, the R & D, followed by the VC stage and PE stage. And then, the Chinese, of course, are brilliant at scaling up and getting the costs down. So, you know, you could, if you looked at the world without the lenses of national barriers, you would say that good old economics is working quite nicely at the moment and the, you know, the U. S. based super research institutions and government funding gives up the new technologies. The U. S. venture capitalists put them together. They get to market. The Chinese will get involved with the IP and that's the key. It has been a way everyone's happy with. And then, it goes to scale and the prices fall through the floor. It seems to be working in solar PV as we've been discussing. So, I think, yeah, I think this can be a global model and, sometimes, I think, you know, we always get a bit, "Well, which country is the winner?" I think when you look at it from the IEA's perspective, you don't need a country to be a winner; you need the world to be a winner. And so, you know, sticking to your comparative advantage is not a bad idea, according to all the stuff we've been taught. So, yeah, at that time, you can sort of get even a bit optimistic that everyone's doing solar and specializing where they should in one sense. And things are actually panning out, according to the textbooks, but they have a lot of ups and downs and disruptions. And it's during those ups and downs and disruptions, like we've had a few, that people get a bit despondent and nervous that it won't happen. But, you know, our view, for what it's worth, is that solar PV is, basically going to be at grid parity against retail in most of the major markets in the

next few years and, you know, by the early 2020's, could be pushing down to challenge wholesale. We think that gas will provide a bridging fuel and it has to be bridging. We hear Markus, you've pointed out, "Well, it's the problem in from 2030 on. It becomes the problem." But, it may be the savior in the interim in some economies. So, if you can use the gas to bridge, you can get the cost down of renewables dramatically and not just in solar PV. And you can get further cost reductions in wind as well. And then, you can get new technologies coming to the market. You know, maybe we won't get 450 parts a million, but at least we might hold it somewhere below 600.

Victoria Healey: Thanks, Mark. Rock has a follow up question based on the discussions. And what he's asking is, are you making assumptions regarding grid parity with renewables on a country by country base or are you using the same discount rate for all cases?

Markus Wrake: Thanks, this is Markus here. Yeah, we have different assumptions around costs of capital for different project types and also in different regions. So, we do find and take into account different assumptions and so forth. We will have a special little feature on relative compared as a different generation technologies for the U. S. in the upcoming ETP. This is something that we're working on, but it's very hard, actually, to do a grid parity analysis and, sometimes, I think it's easy to be misleading in that kind of analysis, especially if you base it on the Levelized cost of electricity. We need to understand, you know, for example, what types of – where on the load curve are you competing? Are you at peak load or a base load type of perspective, for example? And all that will matter quite a lot when you pull that grid parity. But, again, we'll publish an example for the U. S. in just over a month's time. So, that will – and we'll continue to work on that topic 'cause it's, obviously, it's a very interesting one. But, in general, the average cost of generating electricity in our scenarios will go up in all of them, but we see that they converge. So, around, you know, on average, around 2030, we'd have the cost of generating electricity in a low carbon system, it's especially equal to that of a high carbon one, mainly because the possible fuel prices will be lower in a low carbon scenario and because the cost of generating technology will continue to *[inaudible]*. So, hopefully, that answers at least half the question.

Mark Fulton: Markus, could I – it's Mark Fulton. Can I throw out a bit of question back to you? I – we're increasingly getting a bit concerned about this whole LCOE approach, which I know we all use as a rule of thumb. But, of course, you know, any project developer will tell you LCOE's just in the project. I mean, every

project's different and, you know, let alone every region and every country, but, as you've already intimated. But, it can lead to a lot of misinformation, we feel, and a lot of people might draw all sorts of wrong conclusions because it is what, where, when and how in terms of LCOE. And as we know, you know, solar is probably more valuable than wind in one sense if it replaces the peak load rather than the overnight, you know, off peak loads if wind blows at night and so on and so forth. And then, you got all these risk factors and so on. So, do you guys, at times, also get a bit concerned that, you know, it's really such a granular question that we're, sort of, maybe, missing a lot of information because we average it up too much?

Markus Wrake:

Yeah, I certainly agree with you and I tried to refer to mine just now. You know, you're absolutely right and it's much more difficult, I think, to analyze electricity prices than what the L3 concept, sort of, allows for and that it's very hard to capture the nuances that you just mentioned in that sort of one number. You know, that also, unfortunately, makes it more difficult to answer some of the obvious questions like, when solar will be competitive? Well, it all depends on what market you're in and, you know, what kind of storage capacity you're building and what size of turbine you have. So, you, you know, what kind of, as a competing capacity, do you face with that module? So, I, you know, I guess the short answer is, yes, we share that concern and we try to address it, to some extent, in our modeling. Ideally, if you want to look at how much, for example, solar will come in and at what point in time, you need a slightly different time and model about what we use most often in analysis. You need a very detailed dispatch model, including how the market structure is set up and so on and so forth. So, it quickly becomes very complex.

Antonia Gawel:

I guess, just to add one point, I mean, you'll see in the early release, the tracking report also, that where we do have costs, I mean, for both technologies, we tried to provide an estimate of the cost, not the levelized cost, but the cost of the technologies and a lot of people ask us, "Well, you know, why is there such a large bar?" I mean, we have a quite a huge – there's quite a huge range in the cost of the technologies and that speaks, in part, to the challenge that was just mentioned in terms of the regional variability and the cost of different technologies. But, hopefully, we can provide somewhat of a broad enough overview to be able to see the extent to which technologies are more or less expensive, broadly, than each other. But, it is very difficult to give a very precise answer to that question. Again, also, from the timing perspective, as the market's evolving, some technologies, very quickly, it is difficult to keep pace with the rate of change and the

regional specificity's almost impossible to illustrate at this level of analysis, at least.

Mark Fulton: And if you don't mind my adding, in a sense, I think this is going to be the wildcard as we approach what people think is grid parity, potentially, having said, "Well, what, where, when and how?" Nevertheless, as it's sort of these costs are falling, you know, the good surprise might be, in fact, there's a lot more high capacity projects that are gonna come on stream and surprise us all and because, you know, there's a lot more better quality than we thought out there and financing costs are coming down. And, suddenly, you know, this thing really takes off. That's the real hope of it all. The flipside of that is, in fact, we've used up all the best sites, all the best capacity. You know, these costs are gonna stall and so on. So, I mean, that's the two arguments I hear and, of course, we live in hope that it's the high capacity, cost of capital coming down and then, you know, these things stand on their own and they really take off.

Victoria Healey: Alright. Thank you, everyone. And I have one last question that you really, pretty much, already addressed, but just to toss it over the fence to probably get a prediction on this. A question was asked, what is the expectation of cost reduction in PV modules by 2020 compared to current prices? I don't know if you have any final thoughts to add to –

Mark Fulton: Well, it's Mark again. I'm gonna kick off here and I didn't say it earlier. If you look at the classic learning curve, which was meant to have this 20 percent reduction in costs for every doubling of capacity, I think there was an earlier question on the phone that pointed out we've now, sort of, you know, there's been a dislocation in that curve in the last two years where it's just dropped through the floor. It's no longer a nicely declining line. I mean, it's just collapsed. So, that could either be, you know, that's very encouraging or companies are operating below their cost of capital. They're operating unsustainable margins. The winners are gonna win and after they've won, there's gonna be a snap back in prices and then, you're gonna see that longer term cost curve come into play. This is really a critical question for investment markets in the short run and for the whole grid parity in the long run. Have they overshot at the moment? Are they sustainable? I mean, I think it's a really tough question.

Antonia Gawel: I guess, maybe, just to compliment that, there was actually quite an interesting round table discussion at the Clean Energy Ministerial specifically on solar PV and solar PV markets. And there was quite a lot of discussion around some of the recent – some of the very

rapid trends in that particular market and the fact that it is very difficult to predict costs at this point in time.

[Laughter]

I mean, you know, from the IEA and from the ETP perspective, I could say we do have in the reports a graph that tries to – that illustrates what our model shows of our estimated costs in 2020 for solar PV rooftop modules. So, you can find that in that graph. The costs are expected to drop by about half, at least, over the next decade. But, again, it's very difficult to predict. As Mark mentioned, there is a, sort of, market consolidation happening at the moment at the same time as policies evolving in certain countries, which may have an impact on some of the future investments in Europe, for example, in solar PV. But, broadly, the technology continues to be, well, to be improving in terms of both costs and also deployment. So, the outlook looks quite positive. It's just hard to say where, exactly, it's going to go.

Victoria Healey: Thank you, Mark and Antonia. And that, pretty much, wraps up the questions we've received. So, I would just ask our panelists if you have any closing thoughts or comments that you'd like to pass on to the audience.

[Next Slide]

Markus Wrake: Well, this is Markus here from the IEA. I'd just like to thank everybody for taking part in this. It's impressive to get so many experts online for such a long time. And we'd be happy to also respond to the questions over email or if you want to get in touch over the phone. Just, yeah, give us a ring or shoot us an email and we'll do our best to respond. Thanks a lot for taking part.

Antonia Gawel: And, I guess, thanks from me as well. And if you do have any comments or suggestions or ideas on the report, we're always looking to improve the analysis, so feel free to not only ask questions, but also come to us with suggestions as well.

Mark Fulton: And from my perspective, at Deutsche Bank, if you got any follow ups on financing and that sort of stuff, I mean, either come via Antonia or to us direct. Thanks.

Victoria Healey: Great. Well, thank you, again, Antonia, Markus and Mark. You've been outstanding panelists and we really appreciate your time and sharing the information and analysis and of financial perspectives that you've given us today. And then, of course, on behalf of the Clean Energy Solutions Center, I'd like to thank our audience for participating in today's webinar. You've been a terrific audience

and we very much appreciate your time as well. Again, please check the Solution Center website next week if you'd like to view the slides and listen to a recording of the webinar. And we also invite you to frequently check the training page for upcoming webinars and other training events. And please inform those in your networks about the Solution Center resources and services and, on that, I'd like to wrap it up and just say have a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. Thank you.

[End of Audio]