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CLEAN POWER BEYOND 2015: A DECISIVE MOMENT FOR THE FUTURE OF RENEWABLE ENERGY

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Introduction:

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P R O C E E D I N G S

MR. EBINGER: (in progress) action with the IEA because my first job as a very junior officer in the Federal Energy Administration back in 1975 was at a junior staff level setting up the IEA. That was a very hard thing for a 25-year-old man to have to go to Paris and, you know, meeting after meeting. Probably the best job I ever had.

But we're here today to have the IEA highlight for us a brand-new study they have done on renewable energy, which concludes, without taking the thunder from them, that electricity growth coming out of Paris will be the fastest growing electricity source in the world. And, of course, as many of us know, a lot of that growth is expected to occur in the major emerging market countries, particularly India, China, Brazil. And, of course, what form this electricity growth takes will be vital to whether we achieve the goals, hopefully, that the world agrees to coming out of the COP meeting in Paris.

Our format today will be that we'll have both our speakers make part of the presentation. Michael Waldron will be the first. He is an energy market analyst at the IEA in the Renewable Energy Division. He's the project manager and lead author of the IEA's Medium-Term Renewable Energy Market Report. And at the IEA he previously worked on oil markets and as a biofuels analyst.

Prior to joining the IEA, he worked as a senior energy market analyst at Lehman Brothers in New York and London. And he obtained his M.A. in international energy policy and international economics at Johns Hopkins University just down the street, where I never had the privilege of having him as my student, but I taught in that program for many years.

After Michael speaks we'll have Heymi Bahar, who works at the IEA as a renewable energy market analyst focusing on the Medium-Term Renewable Energy Market Report, which is published annually. Before joining the IEA, he worked as a trade policy specialist at the OECD, where he focused on renewable energy and trade issues. And prior to that, he was involved in a consultancy project with the World Bank and SAIS on the arsenic contamination of water in Bangladesh.

He graduated from Sabanci University and holds a master's degree in energy resources and environment from SAIS. And I have the privilege of saying he was my student, so it's even more nice to have you here back again.

Without further ado, I'll turn it over to Michael to start the presentation.

MR. WALDRON: Okay, thank you very much for the introduction and thanks for having us. This is actually the first U.S. presentation we're doing on the Medium-Term Renewable Energy Market Report. It's a long acronym. We refer to the report as "mister-mister" so if I say this during the presentation don't confuse it with any other cultural references. (Laughter)

The report was launched at the beginning of this month, the G-20 Energy Ministerial in Istanbul. We launched it there because the G-20 had a focus on renewables and then specifically how to enhance domestic policies to scale up an acceleration of renewables. And so a lot of the main messages around the report are oriented towards achieving the same and achieving this goal. This is the fourth edition of the report and it fits in very nicely with the renewables analysis that goes on in the IEA, both within our division, the Renewable Energy Division, and the larger IEA.

So the MRMR is a five-year forecast. We try to identify the drivers and challenges for renewable deployment across the electricity, across the biofuels for transport, and across renewable heat sections. Most of this presentation has to do on the electricity side and we'll present to you our main case, which is basically a baseline sort of reference case, and an accelerated case, so what could happen with certain policy levers being changed in terms of renewable deployment.

This analysis feeds into other IEA analyses you may be familiar with, such as the World Energy Outlook, Energy Technology Perspectives, Tracking Clean Energy Progress. These are longer term-oriented publications which do long-term scenario analyses, telling us how to get, how to meet certain objectives, particularly related to climate change, which is very poignant right now. We also have other work streams on the grid integration of variable renewables and also long-term technology roadmaps focused on renewables.

So I'll get into the substance. Basically, it's a very interesting time in energy markets and we're very privileged to be able to launch this report at this time because we see a number of things changing and a number of things changing in a way which seem to favor renewables, at least on the surface. So we see for the first time in 2014 the global economy has shown signs of decoupling from carbon emissions, so this is as a result of basically the global power mix getting cleaner, but also getting

more efficient, as well. So the role of energy efficiency is very important here, not just on the electricity sector, but in some ways related to, for example, tightening vehicle fuel economy standards like we've seen in the U.S. It also relates to fuel switching, as well, which has also been a big theme in the U.S., the switch from coal to gas for economic reasons.

At the same time, there's a number of macroeconomic factors that ostensibly raise challenges for renewable deployment. So fossil fuel prices across oil, gas, and coal are at multiyear lows. Of course, the oil price fall over the past year has been the most poignant. Gas prices in the U.S. have been low for a few years now, but they're now very low. And we see this actually occurring across a number of regions where gas prices have fallen and coal is low, as well. So how does this impact upon the competitiveness of renewables, specifically in the power sector?

We see emerging markets actually starting to slow economically, so China's starting to slow, Brazil's starting to slow. This impacts upon the demand picture, the robust demand picture that was just described in the introduction. At the same time, a number of OECD countries continue to grow slowly economically, raising challenges for basically scaling up anything in any power sector.

But we also see the prospect for interest rates to start rising from the U.S. Fed. A lot of renewable development in the past five years has occurred in an environment of very low interest rates. Renewables are very capital-intensive, so this has been favorable in terms of financing. What happens if and when interest rates go up? So these raise a number of risks.

Nevertheless, we find that the overarching policy drivers for renewable deployment remain robust globally, and I would put these into three categories. The first is related to energy security, diversification of the fuel mix, diversification of the power mix, less reliance on imported or volatilely priced fossil fuels. Another is related to local environmental concerns, so most notably air pollution concerns in places like Beijing or New Delhi, which is prompting a build-out of renewables in China and India, and, of course, the larger sort of global decarbonization aims related to COP21.

What we see is that a number of pledges have come in for COP21 and the IEA actually just issued a special report yesterday, a very thin one, sort of giving a wrap-up of what we see in terms of the INDCs, the pledges being made for this conference. The INDCs submitted so far cover about 90

percent of the world's emissions and about 40 percent of these INDCs contain some sort of target or some sort of goal related to renewables. So renewables are actually a key feature of a lot of the pledges we've seen ahead of COP21, and I'll tell you the reasons why for this in a few slides.

As a result, we see over the long term -- and when I say "over the long term," I mean around 2030 -- the IEA sees renewables becoming the first source for electricity, so renewable generation exceeding that of coal, which is quite remarkable given where the two stand right now. Coal still beats renewables by a large margin today. But addressing policy uncertainties and market integration uncertainties in the next five years is crucial to achieving this, so this is why we do this report, in order to have a benchmark, a bottom-up benchmark to assess how well we're doing in terms of reaching these long-term goals.

Now, when we look over the next five years and we look at the type of additions that are going to be made in the power sector, one thing we see is that renewables are increasingly dominating what is being added to the power sector. So there's a couple themes on this chart right here.

The first is that relative to the previous period, the amount of new capacity needed in the power sector is actually going down. This is due to structural regions in the economy. This is due to increased energy efficiency. But this gap right here that you see between 2008 and 2014, and 2014/2020, is about the size of India's power system. So the world needs less electricity going forward.

At the same time, in 2014, renewables deployed at record levels. Renewables accounted for almost half of the net additions to the power sector. And when I say "net additions," I mean the growth from point A to point B, taking into account retirements. Renewables accounted for almost half of this growing at a record rate and this is in line with what we see in the previous five years. But going forward, we see renewables accounting for about two-thirds of the new net additions to power capacity, which is quite significant and unprecedented basically in terms of the historical trend.

If you take hydropower out of the mix, hydropower is, of course, very important, but if you take hydropower out of the mix, non-hydro renewables -- so things like solar PV, things like onshore wind and offshore wind, geothermal -- these are accounting for about 50 percent of the net additions going forward. So clearly, something has changed in the power sector and renewables are playing a much

more important role in meeting new demand needs going forward.

Now, if you look at this from a generation perspective, over the past decade we've seen very strong momentum in terms of renewable growth. So in 2013, renewables occupied about 22 percent of the power sector in terms of generation. By 2020, we see this rising up to 26 percent. You could, of course, see the very strong role of hydropower historically, but over time the role of non-hydro renewables continues to rise.

But when you put this against IEA long-term scenario analysis, what is actually needed to meet climate change objectives -- and I'm going to define what we think is needed to meet climate change objectives as the IEA 2 Degrees Scenario. So it's basically the energy mix that we need in order to limit carbon emissions to give the world a 50 percent change of 2 degrees of climate change this century.

Now, a number of low-carbon technologies play a role in this. Energy efficiency also plays a role, so the amount of total generation that would otherwise be needed is actually lower. But renewables need to rise to more than a third of power generation to meet this 2DS. By 2050, this rises to 65 to 75 percent, depending on the performance of other technologies.

So clearly, there's a long way to go. Clearly, there's a lot to be done in terms of scaling up renewables to get a more optimal power mix to meet climate change objectives. But the trend that we've seen in the past 10 years, even though it's been strong, is not strong enough. Getting from here to here is quite a jump in five years and it requires an acceleration of what we're seeing in our forecast right now. And Heymi will discuss that in the second half of the presentation.

Now, that's on the electricity side. On the heat side and the transport side, so we have to remember electricity only accounts for about 20 percent of total final energy consumption, so the rest is actually being done by heat and it's been done by transport and it's being done by a small sort of other category. Electricity is responsible for about 40 percent of the emissions, though, so in terms of climate change it's very important, but we can't forget the heating and transport sectors.

We see slower growth in these sectors with relation to renewables. So renewables in transport is mostly biofuels. Due to structural regions, due to cyclical reasons related to oil prices, we see

very slow growth in biofuels over the medium term. Biofuels, of course, also need to transition to something more sustainable, so we're talking about advanced biofuels, which are biofuels coming from non-edible foodstuffs. We've seen some progress in this area over the past year, year and a half, but it's not enough and biofuels are not on track to meet longer-term climate change objectives.

The same goes for the renewable heat sector, so we're talking about technologies like bio energy for heating use, solar-thermal water heaters, the use of geothermal. Renewable heat is very much linked to the efficiency sector. The way that renewable heat is structured is a much more fragmented, much more distributed way than, say, renewable electricity where you have centralized grids and it's actually much easier to regulate and to monitor and to create policies. So the policy attention we've seen in the renewable heating sector has not been as much as in the renewable electricity sector. Most of it has come from Europe, with some support schemes, and also a number of schemes in non-OECD countries trying to scale up solar-thermal water heaters. But nevertheless, the progress we're seeing in these other two areas is still not as fast as that in electricity.

Now, going back to the electricity sector, why have renewables become so important? Why are they playing a larger role in the power sector? Why are they in so many of the pledges made ahead of COP? Well, I would say the primary reason is because the costs continue to fall. Let's remember that in terms of renewable technologies -- technologies like hydropower, geothermal, some bio energy for power -- these have been by and large competitive versus other sources of electricity for a while. These are mature technologies.

What has been interesting over the past few years is that the prices of onshore wind and solar PV have come down quite dramatically, actually. And this is changing the picture of power markets in many places around the world.

From 2010 to 2015, we saw about a 30 percent drop in onshore wind costs. We model another 10 percent drop -- this is a global average -- from 2015 to 2020. The difference in solar PV is much more striking, so orders of magnitude drops in costs for solar PV. From 2015 to 2020, we still see continued reductions in costs.

Some technologies, though, remain more expensive. Offshore wind is a very good

example as projects have gone farther from shore and have had increased capital and technical requirements. The cost of offshore wind have actually gone up, but we, again, view them as being coming down over the medium term in terms of what we're modeling.

So what's the big takeaway from this? The big takeaway is that we no longer need high levels of incentives to deploy solar PV and onshore wind in a number of places around the world. But as I'll show you in the next two slides, the economic attractiveness of these technologies still depends on the regulatory framework and the market design. So lower incentives, but policies still really matter for making these projects bankable and making them investable.

Now, these are just modeled costs, basically. And so what are we actually seeing in the real world in terms of real world data points? And when we look around the world at onshore wind and solar PV projects that have contracted in the past year and a half, two years, we're seeing these data points being validated in a number of places around the world. And we're seeing costs coming down for basically three reasons.

One is sustained technology progress, so the costs of the capital equipment coming down, increased deficiency, more innovation on the technology side.

Another is that we're seeing deployment spreading out to newer markets, so newer markets that are outside of Europe, outside of the U.S., which actually can have been resources in terms of wind and solar. So the better resources you have, the lower costs you're going to have in terms of generation.

And another reason is related to financing. So the financing conditions for renewables have improved, but there's a caveat associated with this. The financing conditions are heavily associated with the enabling environment or the policy framework under with renewables are contracted or renewables are procured. So what we're seeing is that the best results are being obtained in the countries where there's the availability of long-term contracts to give investors visibility over the remuneration of the asset over its lifetime because renewables are very capital-intensive. A lot of the costs are born up front and operating costs are very low over the lifetime of the asset.

This is being combined with price competition mechanisms, so, for example, auctions or

tenders where different projects are competing for a given remuneration level and forcing prices down. Good resources I've already mentioned. And also the role of limited financial de-risking measures. These are oftentimes public measures, so you oftentimes have the availability of some concessional financing, republic de-risking measures to help bring down the cost of capital. And when you bring down the cost of capital, you get some very attractive rates, and I'll try to give a benchmark for what this means versus other forms of generation on the next slide.

But what we're seeing is in places like Dubai, you can get solar PV for less than $60 per megawatt hour. In places like Egypt, you can get onshore wind for less than $50 per megawatt hour. In these places renewables can be, I mean, depending on what they're competing against, but they can be more cost-effective than alternatives, so, for example, gas in some of these places. In South Africa, renewables are more cost-effective than building new coal plants. So this is actually a major step change and a bit of a leapfrog, you could say, in terms of the way costs have come down, and we're seeing this in emerging markets, but we're also seeing it in more traditional markets, such as the United States. And we're even seeing it in Germany, where PV is now below $100 per megawatt hour. Germany is not a place where there's really good solar PV resources, but it has a lot of solar PV and, with the right framework, costs have come down over time.

Now if you tried to compared -- sorry, going back here, just one last thing on this slide, so in terms of giving a range of where we see new costs evolving, onshore wind can be built in a lot of countries around the world now on the order of 60- to $80 per megawatt hour; PV, 80- to $100 per megawatt hour. I would caveat this, though, by saying that these are the best prices we're observing. This is not happening everywhere, so this is not happening in Japan. It's not happening everywhere in the United States. It's not happening everywhere in Europe. But it does show you what is possible over the next few years given the right policy environment, the right financing conditions, and technology progress.

Now, what does that mean in terms of alternatives, in terms of competition with fossil fuels, for example? This is kind of a complicated chart, but if you took that 60- to $80 per megawatt hour range I said for onshore wind and you said, okay, these are the gas prices at which that would build a

new gas generation plant basically, a CCGT, you would find that over the past five years, at least over the past decade, this 60- to $80 mark is actually quite comparable to where gas prices have been and resulting gas generation costs across a number of regions. It's not so true in the U.S., where, of course, gas prices are correspondent to the blue line down below. But it is true for places in Asia and places in Europe, as well, even in the lower gas price environment.

So we can say with more confidence is that renewables are increasingly cost comparable to alternatives. But, of course, this doesn't give you a full competitiveness assessment and this book doesn't give a full competitiveness assessment either because it's still an ongoing piece of work both at the IEA and elsewhere. So if you really wanted to compare not just the levelized generation cost between these technologies, but you wanted to do a fuller competitiveness assessment, you'd have to compare the value of the electricity generated. So how is the value of wind output or solar PV output in terms of where it's delivered and when it's delivered? And here the variability issue of renewables enters into the question because they're not dispatchable like gas generation is.

You'd need to take into account, okay, if you're going to have higher levels of renewables in your system, what are the flexibility needs? You have to accommodate for that. And we can discuss that more in the Q&A if you want, but these also cost money in terms of maybe changing operational procedures, but also in terms of investments.

But at the same time, you would want to take into account also the externalities from fossil fuels. So you'd want to take into account -- this doesn't include any carbon pricing in here, but you'd want to take into account the negative environmental externalities of fossil fuels and also the possibility for fossil fuel price volatility, which you basically know the costs of a wind plant over its 20- to 25-year lifetime, but gas prices can exert significant variability, and so renewables can provide a hedge against that.

My last slide, and then I'll turn it over to Heymi, sort of wrapping up this whole theme is that basically we see that more renewables can be deployed now for less money. It's a very simple statement. A lot of what's being deployed over the next five years is related to solar PV and onshore wind, and we believe that this can be done more cost effectively than in the past. So capacity goes up at

the same time that investment goes down. It's very simple.

And I'll turn it over to Heymi to give more details.

MR. BAHAR: Thank you. I'll talk about a little bit like the geography, where is this growth happening we just mentioned? So we basically see 700 gigawatts of new capacity coming online between 2014 and 2020. Just to give you a benchmark, this is twice the whole Japan's electricity size, so it's a very big capacity coming online.

And when we see a big trend that basically the capacity growth is shifting from the developed countries to emerging and developing countries, and these new renewable capacities are expected to meet their demand growth. However, when you look at OECD markets, we still see that they still deploy renewables. When we look at the European Union, although the demand growth in the European Union has been sluggish and is expected to continue to be slow, we see 13 percent of new capacity coming online in Europe. And despite all these uncertainties in the U.S. related to federal tax incentives and other Clean Power Plan policy, we see U.S. taking 9 percent of the growth. And after the nuclear situation we see also Japan deploying a lot of solar PV over the medium term and takes up the space.

However, there is an undisputable market which basically takes up around 40 percent of the growth. It's China. China's growth is basically driven by local pollution concerns and basically a government-led carbonization agenda and basically high economic growth, which is disputable right now over the last few months. We can discuss that later.

But we also see other markets contributing and basically accelerating their growth. It's India, Brazil. And I think that the most important thing in the chart is also rest of non-OECD countries, where their growth is equal to basically Europe. So we are basically seeing spreading out capacity.

Let's look at the U.S. a little bit. This is the U.S. forecast over the medium term and this is how we see U.S. renewable energy, annual additions going forward between 2014 and 2020. We give a little bit of history.

So there are three drivers of U.S. growth. It has been these three drivers. One is the tax policy, federal tax policy, production tax credit for wind and investment tax credit for solar. This was the

main policy that was driving. And there's RPS at the state level. And there are also other state-level policies which are basically driving the growth, especially on the residential and commercial solar PV.

However, we see U.S. growth a little bit bumpy, as you can see here. And because we assume that federal tax incentives are expiring in our main case, which means by the end of the year they expire and then we basically see, in 2017, a dip because of this situation. And we see a little bit of going forward after the second part of the forecast in 2018. This is mainly due to competitiveness, improvement of the renewables, and, as Mike mentioned, the cost decreases. So we can have a discussion about this, obviously. Our accelerated case is a little bit more optimistic than this, but we see mostly wind and solar being the driving force of renewable growth in the U.S.

And I want to take a closer look on wind and solar as they are the driving forces. So onshore wind, U.S. is prone to be one of the lowest system costs on onshore wind in the world. U.S. has a great manufacturing industry. It's a very competitive market where a lot of turbine players are in, and you can actually have very large projects, especially in very windy areas. So we see, compared to other countries, we see United States in between Germany and China in terms of costs and we see costs in the United States going forward decreasing about 15 percent. These are the system costs, which means the capital expenditure that you want to make in wind investment.

But when we look at the generation, and, of course, the chart on the right is a little bit more complicated because we want to put things into the context to understand who is more competitive than the others, which technology, so we see that currently -- these do not take into account basically any tax incentives or subsidies, so these are pure costs including everything, we see wind, typical wind, not really competitive with low gas prices and gas generation in the U.S. right now. However, there's a big question mark about the gas prices going forward. So you can see on the right you will see how gas prices can increase and affect the generation cost of gas. And at that point we see a little bit of chance that wind and gas can be comparable. I don't want to say competitive because, as Mike said, competitive assessment is basically more complicated than this. However, we see wind generation costs decreasing and basically maybe, depending on gas prices, be comparable with gas.

Going back to the solar PV, mostly U.S. solar PV deployment was driven by the utility

scale plans. We expect two-thirds of the new capacity coming online as well from the utility scale plans. But I wanted to just show you basically on a residential and commercial scale where the U.S. stands.

Still the U.S. investment costs for distributed PV, which holds a great potential, is relatively very high. This is basically due to soft costs because module costs are basically like a commodity these days and they consist of 30 percent of the overall system cost. But the other 70 percent -- actually 75 percent these days -- consists of soft costs, which include licensing, permitting, and all the other balance of system costs, which are still high in the U.S.

So going forward, we see U.S. capacity. These are cumulative additions starting from zero in 2014 going forward. We see U.S. to basically deploy more than 60 gigawatt of new capacity in our main case with a caveat, obviously. U.S. main case is slow because of the expiration of tax incentives. However, if this policy changes and we have a better signal from a Clean Power Plan or a better signal during the COP meeting in December in Paris, we can see this picture changing. And with the further competitiveness of renewables in the U.S. market, we see that the U.S. capacity can increase 45 percent more instead of 30 percent in the main case.

So I will basically walk you through three major markets which are driving the forecast. First, undisputable, China. China has a very strong policy to deploy renewables. And just to give you a context, by 2020, China is expected to install more than 200 gigawatts of cumulative onshore wind and offshore wind together. This means one-third of all wind turbines installed in the world by 2020, so it's an incredible market.

For solar PV, the situation, as you can see, it's increasing very fast driven by local pollution concerns. And China wants to basically push renewables because of decarbonizing its sector a little bit and diversification from the coal. So for solar PV, the growth is even more drastic because China just started to support solar PV and we expect the growth to go very fast from around 30 gigawatts to over 100 gigawatts, and even a higher accelerated case if costs come down and some of the challenges are met at the distribution level.

So Europe, former leader of renewable energy, the biggest contributor of cost decrease, is going down. It's clear because this is mainly due to two things. First, the sluggish economic growth.

As you can see, the Europe market is in over-capacity in terms of electrical capacity installed. And the second thing is that policy uncertainty remains an important issue in Europe: the latest policy changes in the UK related to onshore wind; former policy changes in Spain, Portugal, and Eastern Europe; and in addition to that you have 2030 targets that are announced in Europe but with a lack of governance structure around it, which doesn't give a right long-term signal to renewables. So we see European markets for all technologies decreasing besides offshore wind. Offshore wind will remain basically the technology that is growing very fast in Europe. And Europe will take the lead on offshore wind and will probably decrease the costs as it did for onshore wind and solar PV, and then it will spread out. This is how I see Europe's role in this case.

So we have another very important slide here. It's about Africa. So this is -- we tried to look at Africa and how renewables can meet Africa's demand. And we see first signs of leapfrogging like Africa did on mobile phones. They basically skipped landlines and everyone is using mobile phones. So we questioned ourselves if this can actually happen for renewables. And, you know, according to our forecast, you see here the power demand growth, and when you look at renewables, how this power demand growth meets, we see that renewables are actually contributing a lot to new demand growth in Africa.

This is a good sign. However, there are many caveats in this because electricity markets in Africa are very complex, financing is a major issue. This is a main case picture, so accelerated case that we have for Africa is even higher, which means that renewables can actually contribute more. The question is that if the enabling environment will let Africa do this.

Just going towards a conclusion, can renewables get back on track to meet climate change goals that Mike just mentioned? So, unfortunately, with all this growth, we see renewable capacity going forward leveling off. This is because of policy uncertainty in the U.S., (inaudible) in choosing emerging economies, like China, like India, and uncertainty over the long-term frameworks in Europe.

However, there is a change that we can get back on track in our accelerated case. Here you are our accelerated case and you see an increasing trend. So we see annual investment and

renewables in the main case around 250-, 225-, 230 billion a year, U.S. dollars. In the accelerated case we expect by 2020 this to increase by 315 if it happens, if those policies and challenges are met. So 315 will put us on track with the goal of reaching 400 billion by 2030 according to World Energy Outlook from the IEA mentions. So there is a possibility, but we need to meet the challenges.

One thing remains very, very important is the financing. I talked about investment, how we will make this investment happen. All these policy uncertainties that I mentioned actually boils down to risk and project risk. As Mike mentioned, renewables are capital incentives. You have to make a lot of -- you have to put a lot of money in advance to make that investment. And you see here the differences between two policy frameworks and how a weighted average cost of capital or discount rate, however you want to call it for, for renewables significantly changing depending on policy risk.

We have this. We can put countries in between these two, but if Germany can install an onshore wind plant with a weighted average cost of capital or less than 4 percent, and this is basically more than 15 percent in Eastern Europe or in other countries, this makes a big difference in terms of the generation cost of renewables. So we need a long-term market and regulatory framework to basically address this issue.

And I'd like to conclude with a few points. So, as we said, renewables are going forward. That's the reality. And then we see renewables are spreading out and getting cheaper and being installed all around the world. And we do not see the impact of low oil prices, especially on electricity, to basically half the deployment of renewables. First of all, they don't compete head-to-head with oil generation, only in some countries. And we see that the carbonization agenda and incentive schemes remains robust to basically deploy renewables.

Obviously, there is a challenge because especially solar and wind are variable and there are integration challenges in some countries, especially in Europe and in China and in any other emerging countries. However, we see variability of generation, it's not the major issue. We see variability of policies as more risk than the technical issues of renewables.

And accelerated growth to renewables remains to meet (inaudible) on climate protection goals is feasible, which I mentioned. And one last point on U.S., and I'll finish my presentation, the U.S.

remains very dynamic, a very strong market. However, better policy signals can take the U.S. to a different scale and can be the leader of the renewable energy growth.

Thank you very much. (Applause)

MR. EBINGER: Well, I want to thank Michael and Heymi for making I thought a very interesting, but also somewhat provocative presentation. If I could just use the power of the chair to ask a couple questions and then we want to move as quickly as possible to the floor.

I was curious on your forecast on renewable electricity growth if included in that is the concern about how we bring electricity for the first time to the, people argue about the numbers, but roughly 1.2 billion in the world who have no access to electricity and maybe another billion people who primarily use biofuels with often attendant health-adverse effects. So do your forecast numbers include kind of not just the growth in the world electricity demand, but also that kind of unmet demand that's still out there?

MR. WALDRON: Yeah, it's actually a big factor, I mean, particularly in the slide that Heymi showed on Africa. There's a couple ways to improve energy access. I mean, from the electricity side there's two main ways basically. So you either extend the grid so that more people can take advantage of centralized grid-connected power. Sometimes, in many cases, this can be prohibitive in places like Africa and places like India due to the associated costs. So the other option you have is basically to have mini grids, off-grid systems, which are smaller in scale and which we do take into account in our forecast, but, nevertheless, the magnitude is relatively small in terms of the absolute numbers.

What is interesting is that for off-grid systems for mini grid, the cost of renewable technologies, particularly solar PV, but also some of the associated sort of distributed technology or decentralized technology with it, has come down so much that this is more competitive than using a diesel-fired generator basically. I think this is actually quite obvious. Of course, solar PV won't give you generation over the course of an entire day plus a night, so you would need some sort of either link to a larger grid system or you'd need some sort of storage involved in that. But basically, the economics work in terms of access.

In terms of the extension of the centralized grid, in Africa, I mean, you have a lot of large hydropower projects, you have geothermal projects, you have another of other sort of large projects where renewables are actually helping to contribute to this access issue, but the major constraint is how do you finance and build the transmission? So our analysis doesn't actually try to marry up the number of people without access to the projects coming online, but I know in the sort of longer-term IEA analysis there's a bit more work done on the energy access issue. But given the cost trends that we're seeing, renewables can actually play quite a big role in terms of enhancing that access story.

MR. EBINGER: And I was wondering, also, maybe you've done -- the IEA's done other work on this, but are any of your growth projections for renewables predicated on large-scale battery storage being proven on a commercial scale and scaled up around the world or, as in your base case, are you just assuming growth going along as it is without long-term storage?

MR. BAHAR: I mean, for storage for the coming five years, we do not basically see storage playing a very large role at a very commercial scale because it's still very expensive.

MR. EBINGER: Battery storage.

MR. BAHAR: Battery storage, exactly. Let's not go -- yeah, only battery storage. There are other ways of storage, which have been competitive for years, like pump storage of hydro. However, the availability of this is a big question mark in some countries. We see some countries continue building, like China, pump storage, but if you talk about like a more innovation perspective, we don't see costs coming down that fast impacting our forecast in the coming five years.

However, long-term analysis, long-term scenarios take those costs further down. However, it is difficult to predict, especially at the very (inaudible) scale level storage, which will solve all our problems in terms of the variability. But over the five years, we don't see it coming very fast.

MR. WALDRON: An interesting point from some of the IEA work done on the grid integration of variable renewables, and they look at the different flexibility options for increasing variable renewables to high levels of penetration in an energy system and where you get the most bang for your buck. So in terms of flexibility measures it's having dispatchable generation or having increased transmission or interconnection, so increasing balancing areas. Storage is, of course, another role, but

also having demand side response and demand side management. And actually, this latter point, this demand side management and demand side response, gets the biggest bang for your buck in terms of helping to integrate renewables, particularly because storage is still relatively expensive. So this could actually be a bigger factor in the next five years than the storage aspect.

MR. EBINGER: And one final question and then we'll go to the floor. Recently, Christiana Figueres with the UNFCCC said coming out of the COP meeting in Paris that even if all the commitments that are going into Paris are met, that there is no chance we can keep the temperature rise to 2 degrees and that we are rapidly on track to 3 degrees and perhaps higher. Would the IEA agree with that assessment? You seem to be arguing that this is what we need to do to keep within the 2 degrees, but is it enough or do we need your accelerated case to clearly combat the threat?

MR. BAHAR: That's a very good question. IEA yesterday published its basically scenario for COP21, I will call, and in that scenario, if I remember correctly the numbers, if all INDCs are implemented, it's not enough. IEA agrees with this. It's not enough to reach (inaudible) scenario. And I think, Mike, correct me if I'm wrong, it's 2.7, I think.

MR. WALDRON: Yeah, yeah, yeah. I was going to round up to 3.

MR. BAHAR: Yeah, okay. If all INDCs are implemented we will see a temperature increase of 2.7, which is way higher than 2 percent.

And coming back to if those INDCs are not implemented, then if we go back to basically capacity additions leveling off in our main forecast, probably it will be higher than that.

MR. WALDRON: Our main case is roughly in line with the INDCs. I mean, INDCs are have been coming out steadily throughout the year, so at some point we have to put a stop on when we do our analysis. But our main case is roughly in line with, to give you perspective on the IEA, with the World Energy Outlook new policy scenario, which is roughly in line with the INDCs. So this is kind of the -- I don't want to call it business as usually, but where the world is heading given the policy signals out there.

So, yeah, we said we needed the accelerated case to get to 2 degrees, so we do need much more than what's in the INDCs to get to 2 degrees.

MR. EBINGER: Okay. We will go to the floor. All we ask is you identify yourself and, hopefully, ask something that has a question mark at the end of it. (Laughter)

Why don't we go to the gentleman -- we have roving mics if you'll just wait a minute.

MR. WEINBERGER: Thank you very much for the presentation. My name's John Weinberger. I'm from water academia.

And you mentioned on your very last slide with your conclusions that the price of oil is not very important in the deployment of renewables, and I'm wondering what you'd say about the price of natural gas. And also, whether you've run any hypothetical scenarios on taxing carbon dioxide emissions and, you know, how different scenarios work out.

MR. WALDRON: Yeah. So the price of gas is actually important basically, and that's why I showed the slide in terms of comparing the costs that we're seeing for renewables versus alternatives, specifically gas. Because gas composes a large amount of mid-merit and peaking generation and this is increasingly what renewables are displacing in many places around the world. So in terms of the head-to-head competition it's more about renewables versus gas than oil. I mean, gas prices, and I'm not a gas expert, but, I mean, gas prices, the oil link between gas is -- you know, there is a contractual link in some places, but in many places there's not. And gas markets have been going to their own tune, their own supply and demand dynamics. So in that way the oil price has limited effect on the renewable sector.

But what we still see is that even in places where gas and renewables would go head-to-head, it's still the policy environment for renewables which is supportive in a place like the U.S. So the option to have a long-term power purchase agreement available for renewables to give that sort of long-term contractual security in terms of remuneration is very important for renewables because given their capital-intensity, if this is available. So if you have the right market framework which offers these type of contracts -- and we do see this is many of the world and this is why we say that renewables are not so affected by what's going on in terms of fossil fuel prices. But, of course (inaudible).

MR. BAHAR: But there's a caveat on this, as well. Electricity is not affected or there are more vulnerable renewable energy sectors, like heat and biofuels. Obviously, we see biofuels going

forward with the planning policies continuing, but it's a question mark obviously how they will be affected with the oil price.

And heat is even more vulnerable because it's a very segmented sector. And then actually in heat, renewables are competing with fossil fuels. And, I mean, when I made that point with the renewables, of course, I generalized it in terms of access, but heat can be actually affected because heat is also weak in terms of policies. So that's a big question mark, as well, I will say.

MR. EBINGER: On the aisle now here.

MR. REGANBOGEN: Herbert Reganbogen. I'm a professor of international relations, international law, and specifically energy security.

My interest is relating to the last weeks where the oil-producing countries, which have been the major investors in renewables in the Middle East, have now discontinued the investment. For example, Saudi Arabia had allocated a $109 billion investment and postponed it for 8 years. And there are other major oil-producing countries in this hemisphere who have done the same. How does that affect your estimates made in this program in terms of the next five years?

MR. WALDRON: I would say, first of all, for major oil producers there is a strong driver for having renewables, basically because if Saudi Arabia burns a lot of oil in the power sector, even at oil prices at this level, that's a huge opportunity cost to be burning oil for power generation as opposed to using solar, which, in Saudi Arabia, the economics would be excellent for solar, both in terms of solar PV, but increasingly a concentrated solar power. So there is an economic driver for the Saudis to switch. They could export a lot more oil if they were using renewables to meet their power needs, particularly given their peak power needs with high air-conditioning demand in the summer. PV matches very well to that.

We are fairly bearish on the Middle East in terms of renewable development. It's ironic because we're seeing the lowest costs for solar anywhere in the world, both in Dubai, but also in Jordan. These countries have more acute I would say diversification needs for their power sector. Jordan doesn't really have much in the way of resources, so it needs to use domestic resources.

But at the same time, you have a number of issues in the Middle East countries where

there's not full access for independent power producers. Many of these -- much of the deployment is going through kind of government-led procurement programs which can only go as fast as the government goes. And in Saudi Arabia, we haven't seen hardly any traction. We saw a whitepaper in 2013 laying out a strategy for the kingdom, but since then we haven't seen supporting regulations, we haven't seen a supporting framework. And so for us it is a big question mark actually because the long-term potential is absolutely huge. In a country like Saudi Arabia, deploying PV at scale through the numbers that they gave could actually be a major force on the world market helping to bring down learning and helping to bring down costs.

You mentioned examples in this hemisphere, the Western Hemisphere. Did you have any particular ones in mind?

MR. REGANBOGEN: Argentina.

MR. WALDRON: Argentina.

MR. REGANBOGEN: Trinidad.

MR. WALDRON: Trinidad. I'm most familiar with Trinidad, but Argentina, do you have any insights on?

MR. BAHAR: No, but the question, I understood your question as this money, where it will go, right?

MR. REGANBOGEN: (inaudible; audio drop)

MR. WALDRON: I mean, in terms of the countries you mentioned, some of them still have robust frameworks for deploying renewables. I would say Egypt is one of them, even despite the gas find. And this is because the costs of wind in Egypt, which I showed is the lowest value on this map that I showed on this slide, are very attractive. And PV is not at that level yet. PV could get closer to that level as time goes on basically.

So even though there are these shifting priorities related to fossil fuels, there's still, because of the resource availability and because of the costs coming down, particularly for solar and also for wind, there's still a good driver for renewables. But that said, overall in the region, and I'm talking about the Middle East, we're still conservative because of these restricted policy frameworks related to

developing power projects in general, not just because of renewables.

MR. EBINGER: Yes? We'll get to everyone.

MR. CAREW: Lawrence Carew from the International Energy Partnership. Dr. Ebinger, this is for all three of you or one of you.

I keep seeing on television these ads for ethanol and how it's a big pollutant. Can you guys talk about that? Ethanol is big Brazil. I don't know what's happened since.

MR. WALDRON: Yeah. I mean, we have an entire chapter on biofuels in the book. We didn't highlight it as much because I know that biofuels actually gets a lot of analysis already in the U.S., so we wanted to kind of show something which is maybe less known about trends going on in the electricity sector.

The biofuels production forecast we have is actually quite sluggish, so it has to do with the structural issues related to putting more ethanol into the gasoline pool in the U.S. And the IEA we've long said that biofuels need to transition to something more sustainable, so away from corn-based ethanol and towards advanced biofuels which are based on non-edible foodstuffs, so based on residues, cellulosic ethanol, based on things which are basically not eaten.

We've seen the first advanced biofuels plants be commercialized over the past year and a half basically, so there's been some progress in the U.S., there's been some progress in China and in Europe, but it's still not enough. The policy frameworks supporting advanced biofuels are not strong enough. In the U.S., the advanced biofuels requirement of the RFS keeps getting reduced every year because there's simply not enough commercial projects out there. So in itself the target is not enough to support he advanced biofuels industry. And if we want to transition to something more sustainable in terms of biofuels, the right policies need to be in place to help de-risk these investments and bring the costs down.

The low oil price environment is also a big risk for advanced biofuels, as well. We've seen only a few data points in terms of the industry cost estimates, but they're well above the oil prices we see now in terms of break even.

A lot of people say do we need biofuels? Do we not need biofuels? What about electric

vehicles helping to decarbonize the transport sector? The transport sector is extremely difficult to decarbonize. And, of course, electric vehicles will play a large role, but what are you going to do in areas such as aviation or shipping? You still need fuels which have a certain energy density, that are decarbonized and produced in a sustainable manner to meet our long-term scenarios. So we still think things like advanced biofuels are important and we think ethanol's important, but you need to have this transition to a more sustainable way of producing them basically.

MR. EBINGER: If I could just add on that, I'm in the embarrassing position, I think I did the first public policy study on ethanol for the Renewable Fuels Association back in 1983. And we argued as an infant industry argument that it should get tax credits and subsidies to get it going. That is the one study in my professional career I am sad to have been associated with because I think ethanol, at least corn-based ethanol in the United States, has been one of the greatest boondoggles placed upon the American people. And if one actually looks at how much you are paying for ethanol in your gasoline today, you would be paying much lower consumer prices if we had no ethanol standard.

I think ethanol from corn has been pretty discredited as a great boon to the environment, which we argued it was at the time. I think you can argue it has done absolutely nothing for energy security, at least in the United States. Brazil may be a different case because of the higher yields they get and also huge employment that they get in Brazil.

But I would just like to go on record, I would personally, when we're talking about the solar industry needing taxes, I would personally get rid of all subsidies for all fuels and then let's have a level playing field to compete, and that includes getting rid of the subsidies for the fossil fuel industry.

Next question, please. The lady over here.

MS. WESTLEY: A related question. I'm Jacqueline Westley from Calvert Foundation. So curious as to why you're not more bullish on biomass and specifically things like anaerobic bio digesters. And if it's a question of policy and tax incentives, what specific policies and tax incentives would you want to see?

MR. WALDRON: I mean, a lot of this development to date, the most positive development, has been in Europe. You see a number of European countries which have emphasized

less bio energy in terms of the policy framework, so the UK, Germany. A lot of the challenges related to setting up a sustainable supply chain and so you would need policy support not just for the plants basically to generate the electricity, but also in terms of supporting the supply chain, as well.

Bio energy, of course, has a very robust potential and it can be economic if you have the right feedstock at the right price. But, again, it's basically a lack of policy attention and decreasing incentives, decreasing frameworks, and decreasing targets for these kind of technologies that we've seen, particularly in European countries that had been supporting them to date.

MR. EBINGER: Yes, the gentleman on the side here.

MR. KOESTER: Hi. Stefan Koester with David Gardiner and Associates. I was wondering if you'd speak to the role that you see CCUS playing in places like China, especially if it's a competing for investments or it's complementary to the renewable investments that you see there.

MR. BAHAR: CCUS?

MR. KOESTER: Carbon capture, utilization, and storage.

MR. BAHAR: So CCS came with a lot of promises a few years ago. However, I think the cost decrease and development of basically CCS at a massive scale has been a little bit slow, including in China. I mean, most of the plans are not in -- most of the trial plans are not in China.

And if you want to talk about China and coal, I think there is a more interesting phenomenon just happening right now, is the decreasing power demand. In the first half of 2015, China power demand grew only by 0.9 percent, which is extremely slow. And then you have a lot of coal capacity being built. And the question mark is that how are these coal capacities going to work there? Because they are also building renewables at the same time.

So that's the big uptake that I took from a conference in China. I haven't heard anyone talking about CCS, unfortunately. But over the medium term, definitely not. I don't think that it will play a big role in decarbonizing China's coal industry. But over the long term, maybe it can play a role, but first there needs to be a solution to more power market design in china that will actually give value to other things like saving emissions. Because there's a fix price of coal, they have to run 5,000 hours, it's almost a requirement, and then that's it. It's not a very developed market, electricity market, in terms of this, so a

price signal almost doesn't exist.

MR. EBINGER: If I could just put in a plug, two of my colleagues, Tim Boersma, who's in the back of the room, and John Banks, one of our nonresident fellows, just released a study last Friday on CCUS predominantly in North America, but it goes into -- they visited a number of the plants that do exist and I think it's a very thoughtful study. But it shows exactly what you were saying, the many, many institutional and financial obstacles to actually getting it deployed on a massive scale.

Yes, sir, in the middle there.

MR. YU: Thank you, Michael and Heymi. My name is Brandon Yu. I'm a student at Johns Hopkins SAIS now actually.

Earlier you mentioned the importance of climate finance in lowering investment risks for emerging markets in developing renewable energy. My question is about what do you see the role of the Green Climate Fund or other potential newer kind of climate insurance -- or climate investment facilities play in lowering these investment risks? Thank you.

MR. BAHAR: They already play a significant role. They've been -- still they've been playing, especially in emerging economies, especially in multilateral finance institutions like World Bank, IFC, Asian -- like all these development banks. They actually play a role in attracting private capital to a relatively riskier country, which is a great contribution. And, of course, this should continue. But in terms of the financing needs, you need more private finance to basically come in and try doing this.

We see the financing moving from Europe to emerging economies, like Brazil, Chile, not really Argentina with the latest financial situation, but it's moving there. There's a big interest of developers and they are basically -- their money is going towards that direction.

But there are also other multilateral climate funds, green bonds, which just started to be deployed, let's say, to collect some money. Green bonds last year reached $36 billion, which can be considered very small, but it's actually a big improvement since 2013. There is a colleague who says that there is money, show us where to put the money. But they never say how to put their money, so that's also a different dilemma. So you need to continue in basic (inaudible) and creating different products to attract more investment. And obviously development banks play an important role, yeah.

MR. EBINGER: Tim?

MR. BOERSMA: Thanks, Charlie, and thanks for the nice comments about our study. Appreciate it.

I missed the first couple of minutes of your presentation, so I apologize if I asked something that you have mentioned, but I want to build on the first question you just received about competitive natural gas. If we look at the world today, you know, it seems that we have abundant and very competitive fossil fuels in general. Right? It's natural gas in North America. As the gentleman asked before, coal in the European and Asian power markets for the time being and maybe gas at some point. If you take that and take into consideration that we don't have any outlook for, you know, a substantial price on carbon anytime soon, I wonder in your models where you foresee that, absent an ideal world where we get rid of all subsidies, where you foresee that renewables are going to be able to out-compete some of those, you know, what seem to be very competitive fossil fuels. Thanks.

MR. WALDRON: I mean, I think from our standpoint in looking at the competitiveness of renewables, and I'll keep going back to this point basically, renewables have a very difficult time competing on wholesale markets based on short-term marginal pricing basically. It's very difficult to recover the offsets. And the more renewables you have in the system, because renewables are low marginal costs, they tend to depress the wholesale price, so they almost cannibalize their own value basically. And so from our standpoint, we believe that the market rules and the market framework needs to be thought of in terms of what kind of system, what kind of market rules do you need to actually get to a deeply decarbonized system? And this may look different from just having an energy-only wholesale market.

And this is an area that the IEA is working on. We don't have the answers yet, but it's a whole work stream of how do you get to a deeply decarbonized market? In that deeply decarbonized market -- and maybe I'll caveat what I said before about renewables going head-to-head with gas. Having a lot of renewables and a lot of gas in the energy system actually gives you a very good flexible energy system that can be cost-effective and decarbonized at the same time.

What is really imperative is to force coal out of the system if you want to meet

decarbonization aims. So how can you get a lot of renewables in the system? How can you get gas to help in terms of the flexibility? And the way this market looks like it's kind of a hybrid between some sort of short-term energy-only market, but the availability of long-term contracts in order to give renewables that remuneration stream, remuneration certainty over the lifetime of their assets.

When you have those kind of long-term contracts available, then renewables in an auction system, as what's happened in Brazil, can actually out-compete gas. So the prices for wind in Brazil are lower than the prices for gas in terms of the auction system.

So it's less about the head-to-head competition. It's less about, you know, how do the economics compare on the wholesale market? It's more about do you have the framework that's available to give investors that long-term certainty over the asset? And if you do, then the cost for renewables can come down quite a bit because of capital matters so much. The cost of capital can come down and this can decrease the overall generation costs.

So I would view the two in a way as being actually quite complementary to each other if you have the right market price signals that are oriented towards a transformed system based on massive decarbonization. If you don't, then you're not going to get there and you may have a perverse outcome like you have in Europe where you don't have sufficient carbon pricing, gas is still relatively high compared to coal, and you're building a lot of renewables, but, oh, by the way, the coal generation is going up, too, so.

MR. BAHAR: // And one last point, maybe. It's really country per country that someone needs to look at the situation. If you're a country and you have a lot of -- if your solar generation is meeting your peak demand during the day, obviously the value of that solar is way more higher than somewhere else.

So the proposition that we are working on is that there needs to be a value to the system that should be priced in the markets, not pure generation. But, of course, it's a very complex issue. You have to look at all the locations of the plants and where they create value, where they alleviate congestion, all of these dynamics, and then you can basically talk about the real value to the overall system, including interconnections.

We hope to go towards that direction. It's very complex, but in some markets in the U.S., where nodal pricing is done, we can see some signals, but it's a very complex market. It was already complex when we created it. We made rules generating per megawatt hour and stuff, but we will see how it moves forward to a more 3 or 0 basically.

MR. WALDRON: I would add one more because it's a very important question and there's a lot of complexities to it and I don't want to take too much time, but also having the right frameworks and pricing signals, so that demand side response and storage can also play a role. So these types of more services, demand side, distributed parts of the electricity system so they can actually play a role in electricity markets because these are very important for flexibility for the entire system.

So unlocking this has to do a lot with the regulatory questions of does storage participate on a market? Or how does demand side response participate? And these are the questions, also, that need to be addressed in order to complement renewables and actually improve the value of variable renewables in a system.

MR. EBINGER: If I could pick up on that point? If we look at Europe, how would you say that the countries that have made a very vigorous commitment to renewables, such as Germany and Denmark and a few others, has that helped or hindered the formulation of a comprehensive European energy policy?

MR. WALDRON: It's probably both. (Laughter)

MR. BAHAR: That's a great question.

MR. WALDRON: I would say, in general, we think things like having nationally designed capacity markets are a barrier to European integration. So, of course, we would like to see greater integration not just in terms of the physical integration, but the regulatory and real integration of European markets. This is actually much better for improving renewable on a European-wide basis than if every country was doing their own thing basically.

MR. BAHAR: Also, Europe has moved in a significant way towards integration. Now all markets, their head markets, are working together. You have some intra-day markets where basically the closing gates are getting shorter, but if you think about in terms of trade perspective -- because electricity

is traded -- if you say that, okay, someone is basically giving a lot of money to extra renewables, the other one cannot, does it make that more competitive than the others? This remains a big issue and U.S. stated aid guidelines last year said that almost feeding tariffs should not be used anymore. Europe should move from feeding tariffs to auction-based systems where different renewables or, depending on the design, can basically have cost-effective generation. And this is happening in Germany. This has been happening for offshore. It's happening in the UK, and it's moving towards a more (inaudible) auction scheme. It's, again, country-based, but it's moving away from feeding tariffs, at least for a new generation.

MR. EBINGER: Thank you. Yes, sir, in the middle here?

SPEAKER: I am (inaudible) from *China Daily*. In China, where coal remains to be the cheapest form of energy, and also it takes up to 80 percent of energy consumption in China, and also we use a lot of hydropower, so how can we make the renewable energy like wind power or solar power more competitive in China? And like what is the latest development of renewable energy market in China?

MR. WALDRON: Well, Heymi alluded to some of the points earlier. A good first step would be to understand -- to have the right pricing signals basically because the signals for the production of coal generation in China are largely administrative or based on the recovery of the assets or also based on heating needs, as well. So, first of all, having the right price signals, to give the right price signals for generation.

Another big step that was taken recently was the Chinese president said that they wanted to make renewable power a priority dispatch basically, which is actually kind of a technical thing for him to announce, but it's actually real important to the integration of renewables into the grid.

So I would point to the fact that China has very good resources, the costs of deploying renewables in China compared to anywhere else in the world are basically the lowest in terms of wind, in terms of the capital cost at least, and for solar PV. And when the resources are right, the generation economics can be very good, but it's really a question of market and system integration.

And as China's economy slows and as its demand needs slow, you bump up more of a conflict where basically renewables coming into the system threaten to push some of the coal out of the

system. And you run into an institution issue, I guess, where you have a very strong incumbency and, at the same time, you have very strong decarbonization, local pollution reduction goals from the Chinese government, from the national government.

And so you need some sort of reform so that basically the renewables do get priority dispatch into the grid and also they're integrated properly so that wind is not being curtailed in the northeast, so that PV can get grid connections. Hydropower is actually great for helping to facilitate this and China's actually building a huge amount of pumped hydro storage or has goals to build a huge amount of pumped hydro storage over the next 5 to 10 years. This will be an enabler, as well.

But you do need a regulatory reform so that the grid companies are basically treating renewables in line with the regulations that have been issued by the national government.

MR. EBINGER: Yes, Christine?

MS. JOHNSON: Hi, Christine Johnson with The Howard Baker Forum. So I've noticed that the dialogue today is almost exclusively fossil fuels and these renewables, like solar and wind. But I did notice one of your charts, Michael, alluded to the growth of nuclear over 2014 to 2020. So I was wondering if you could speak on any models that the IEA has regarding the role that nuclear might play as a non-emitting base load to augment renewables or if it's just going to get priced out in the future, especially with the Clean Power Plan? Thank you.

MR. BAHAR: Let me start.

MR. WALDRON: Go ahead.

MR. BAHAR: So, after Fukushima, as you all know, things became very difficult for the nuclear industry. And even before Fukushima, with the new generation of nuclear power plants, their cost almost increased by 10-fold in France, 9- or 8-fold in Finland. So it's becoming a cost issue and, at the same time, social acceptance issue.

I agree with you that it's a great base load, non-emitting. Nuclear has a role to play in energy systems, but over the five years it's difficult times for nuclear. But, on the other hand, you have UK signing a contract with EDF to basically install a new nuclear power plant, but no one knows how long this development will take, when it will be commissioned, and how it will work out.

And for nuclear it's not only, in my understanding, about giving them a 35- or 40-year fixed payment, it's also about how you manage the risk of the development, how you take that nuclear into the grid and make it produce electricity. It's a question mark.

We were talking before coming in, there is some developing going on, but it's very difficult to say when these will come online and will produce electricity.

MR. WALDRON: That said, in IEA long-term scenarios nuclear plays a very important role. And I'm not here to predict what happens in nuclear because I don't know the market as well as a nuclear expert, but given the uncertainties and given the challenges associated with it and the long lead times, if some of that nuclear does not materialize, what is going to need to scale up to make up for it to meet long-term decarbonization scenarios? And in that regard, the quickness and the flexibility in which renewables can be built up can play an important role.

In one of the energy technology perspectives, I think 2014, they did a 2 degrees scenario where they said, okay, what if nuclear and CCS deploy slower than we expect? This leads to something called the high renewables scenario, where you need 80 percent of power generation to be met by renewables in 2050.

So nuclear plays a role, of course, but you always have to analyze what happens if it doesn't materialize and what is needed by the energy system.

MR. EBINGER: Yes, in the back? We'll get one of you and then the next one.

MS. LAWSON: Hi, Sarah Lawson. I'm a recent SAIS grad. You mentioned that renewables -- often natural gas could be used as a backup and a lot of differing utilities have come out with recent plans where there's a lot of co-generation: wind, solar, battery, and just a ton of different fuels being used to smooth out the system. And I guess a lot of those areas you presented today show the fuels as an island. Could you speak a little bit to these co-generation facilities? If it brings the cost down or if the cost is up, but it's better for long-term grid integration. And beyond the U.S., if other countries are doing a lot of these mixed use systems?

MR. WALDRON: I think co-generation and district heating are great ways to help integrate renewable heating sources into the energy system, basically using bio energy. So these

sectoral links, I think, will become increasingly important. In the medium-term reports it's hard for us to make all of these sectoral links. These are done more in the longer-term IEA scenario analysis, but linking electricity to the heating sector, in general, can actually provide a lot more flexibility for the electricity sector.

You see in Denmark, where excess wind is used to run electric boilers, which the heat can then be fed into district heating systems where, in general, it's easier to store heat than it is electricity. You also have pilot programs in China where excess wind, while they're trying to make excess wind, again, do the same thing as in Denmark: power boilers in order to feed into district heating networks and meet China's heating needs during the winter. And if you meet heating needs using not coal, you can reduce the operating hours for coal.

Of course there is institutional barriers. There's having the infrastructure and then there's institutional barriers associated with this, as well. These will increasingly become important facets of energy systems, but, again, it all boils down to the right price signals. In China, if you're a wind farm operator, being able to trace your electricity into the heating market, there's not that communication signal, there's not that framework in order to do that so that wind farms can get remunerated for delivering heat when it's needed most.

So a lot of it boils down to having the right communication systems and also having the right regulations so that people can be rewarded for when they're delivering energy at the time and the place where it's valued most.

MR. BAHAR: Independent of these regulations there is this new trend that hybrid plants, it can be hybrid like renewables with renewables and renewables with fossil fuels, and they're in some markets, for instance. Interesting developments are happening in Italy, for instance. A geothermal power plant is basically combined with a biomass power plant to basically heat the steam level -- reheat geothermal steam to basically produce more energy.

In Chile, there are combinations with wind and hydro, solar and hydro, solar and gas, and all these new combinations. I can't say right now how cost-effective these hybrid options or these co-generations, but it seems like there's a trend, especially on the hybrid side. The companies are doing it

without many extra incentives, just combining technologies.

MR. EBINGER: I think we had another one?

MR. CLEARY: Yeah, thanks. Colin Cleary, U.S. Institute of Peace.

Mr. Ebinger, you mentioned earlier the subsidies for the fossil fuel industry that are still in the system. I wondered if the panel would comment on which of those are most egregious and what are their effect on the cost equation, and what you would like to see done about those?

MR. BAHAR: I'll take that. Of course, fossil fuel subsidies are not only a story in the developing countries, it's also a story in developed countries. It's oil producing: fossil fuel producer, fossil fuel non-producer. It's a general phenomenon, but the most important ones, fossil fuel subsidy reforms, are happening right now and it's a great opportunity to basically get rid of those subsidies. Indonesia took an incredible reform plan to basically phase out the not cost-effective fossil fuel subsidies because there's an argument that these subsidies are helping poor people to generate electricity, but many studies show that they actually don't. Those subsidies are going towards the hands of middle class and high class, but it's a very good question.

In terms of level of playing field, it will be very difficult to talk about let's get rid of all the subsidies and then see what happens because you have all of these coal or gas plants that are in Europe or in the U.S. that are built 50 years ago or 40 years ago, and they built with probably a certain level of subsidies and they give the signal to the wholesale market that we are operating.

So that's a very interesting question, but there's a big G-20 agenda on phasing out fossil fuel subsidies. I used to work in a project on this and there's an incredible improvement in some countries. And IEA sees this low oil price environment as a good opportunity to basically phase out those subsidies and, hopefully, it will happen. It's among five --

MR. WALDRON: Suggestions.

MR. BAHAR: -- pillars of IEA's, include phasing out fossil subsidies and phasing out inefficient coal power plants.

MR. EBINGER: If you haven't seen it, one of the most compelling studies is one done within the last year by the International Monetary Fund, which I believe -- if I remember the number

correctly -- says that worldwide, if you look at all subsidies, it's somewhere close to $3 trillion. And the study suggests that if we eliminated all those subsidies, particularly those for fossil fuels, we would meet the climate goals without doing anything else. I mean, it's an incredible study.

MR. BAHAR: That study takes into account all costs --

MR. EBINGER: All costs.

MR. BAHAR: -- associated, but it's not only monetary costs that comes up --

MR. EBINGER: Right.

MR. BAHAR: -- when you give money to fossil fuels. It comes like calculating the whole cost of the impact of the fossil fuels subsidies to the society, if I remember correctly.

MR. EBINGER: Right.

MR. BAHAR: It's a very wide range.

MR. EBINGER: And the other important thing to remember is that there are other anomalies in the system. For example, the oil industry and offshore oil leases pays quite a bit of money for those leases. The renewable industry going offshore in the United States does not pay those. So, you know, they work both ways here and be careful what you ask for. But I think that was a very important point Heymi made about the old coal plants and others. It would be difficult if my earlier call for eliminating subsidies with looking carefully at that.

I think we have time for about one more question, unfortunately. The lady in the yellow sweater?

MS. OSUALA: Hi, thank you. My name is Chinyere Osuala. I'm from Earthjustice. I'm a clean energy attorney there.

And I was wondering, Heymi, you said about how utilities will contribute to increasing the amount of solar PV in the upcoming years, about two-thirds will be from utility scale projects. I guess I want to push you on that. How exactly will utilities -- what are utilities' role? What will they be in the upcoming future, especially concerning what we're fighting and participating in, good modernization dockets going on in different states, such as New York Rev and we have one in D.C. that's more doing an investigatory thing? But exactly what are utilities' roles in the upcoming future and what exactly will

utilities have to do in the future years in order to more integrate these renewables into the grid?

MR. BAHAR: First of all, when we talk about utility scale, we mean large projects. It can be developed by either large utilities or free enterprise ones, but the question overall of how utilities will play a role in the changing electricity market is a very valid and very good question.

And it seems to me that we are facing a very important change in the electricity markets. We are moving from classical utility scale -- okay, you have your home, you pay a certain charge for electricity on a fixed cost and then the rest, I mean, it's changing.

So I will make a connection actually with the Internet industry, it's a little bit like this. So you had basically taxi companies, like perfect monopolies. Now you have Uber coming in. Everyone can drive and everyone can be a taxi driver, right? So what's happened, taxi drivers basically got really angry and said that this is our business. You are killing our business. It's the same thing for Airbnb and hotels.

So social media was 2.0; Uber, Airbnb is 3.0. So what is the electricity at 3.0? That's happening in a way advanced level in the U.S. right now. In California people have started to produce their own electricity. Everyone can produce electricity right now with solar power in certain states if they allow you. And then the question is how utilities will react to that.

The same thing for large utilities in Europe, how they react to this. There's a new market coming online which actually is combining demand response ancillary services with IT industry, showing you real pricing signals so that you can basically change your demand accordingly. This all boils down to what utilities want to do with the new changing industry. That's a big question mark. It's not happening in the U.S. It's happening everywhere and we will see who will -- there won't be a winner. There will be compromises, I guess, to basically come to a point where the market works in harmony while transmission and distribution grid costs are recovered.

So let's don't forget that everyone wants to have electricity 24/7, so those investments are very important, as well.

MR. EBINGER: I'd like you all to join me in thanking our speakers for what's been a very lively session. (Applause) Well done, gentlemen.

MR. WALDRON: Thank you very much.

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