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THE NEW DYNAMICS OF GLOBAL ENERGY:

A CONVERSATION WITH IEA EXECUTIVE DIRECTOR FATIH BIROL

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P R O C E E D I N G S

MR. VICTOR: All right, well let's get started. Welcome, everybody, this afternoon, and thank you also for braving the traffic; the World Gas Conference, an event every three years is happening here in Washington, and so the streets are clogged with people from the gas industry.

My name is David Victor and I Congress-chair with Bruce Jones the Cross-Brookings Initiative on Energy and Climate. This is an effort to bake into all of what Brookings does on geopolitics, on technology, on economic growth -- all of what Brookings does, more attention to energy issues and climate issues based on the logic that many energy policy decisions and frankly, most climate policy decisions are constrained and driven to some degree by what countries are willing and able to do for other reasons.

And so that's why we're organizing the Cross-Brookings effort this way. And it' really my pleasure to introduce Fatih Birol who will be with us for the next hour and a half.

Fatih is the head of the International Energy Agency. Prior to that, he was the chief economist of the International Energy Agency; is the face of all of the major products of the International Energy Agency, including its flagship effort, the World Energy Outlook.

He was formerly at OPEC, trained in engineering and in economics in Turkey, where he was born and in Vienna. And you have his bio, I think, in the materials that were circulated in advance of this meeting. I just want to say that there's one very important omission, which is that Fatih is a lifelong honorary member of the Galatasaray football club in Turkey, which is the most important and successful football club in Turkey --

MR. BIROL: In the world. Not in Turkey, it's the world (Laughter).

MR. VICTOR: In the world. I stand corrected.

(Simultaneous discussion)

MR. BIROL: More or less it is, yeah.

MR. VICTOR: And I can say for the Americans, every four years, we're allowed just to call it football, and so enjoy that while it lasts, because it won't last forever.

So I want to say just one thing before we get started, and then Fatih's going to make a few opening remarks about how he sees the big picture changing, and then we'll have a conversation for 45 minutes or so, and then I'll open it up for a broader set of questions and discussions with the audience.

And I guess what I want to say is that frankly, the energy business used to be kind of a dull industry, because you'd wake up in the morning and you'd do the same thing you did before the day before.

You kind of knew where to look for resources. If you were running an electric company, you kind of knew what to do. You'd build a slightly larger power plant, slightly longer power lines. You did the same thing over and over again.

This world is now transforming on almost every single front. You know, the question of what is the -- what of the frontiers applies? Well, now we're looking at horizontal drilling and fracturing of shales in a way that was not conceivable a decade ago, or certainly, 15 years ago.

We're looking at tremendous changes of costs. We're looking in the electric power sector at potentially complete transformation of a grid such that the incumbent companies might not exist in some cases, or maybe they become more powerful. Nobody is quite sure. And of course, amazing changes in technology.

And so on the one hand, that has created an enormous set of

opportunities, and on the other hand, it's created an amazing degree of risk, and this industry is nothing if not capital intensive. And so how those risks affect the future structure of the industry, where people invest, what that infrastructure looks like, those are the central questions.

They are questions that can't really be addressed seriously without a look at the whole picture, a systematic model-based framework and it's hard to imagine anybody in a better position to do that than Fatih Birol. When people think gravitas and energy analysis, they think Fatih Birol. And so it's really a pleasure to have you with us this afternoon.

Do you want to make a few opening remarks as to how you see the big picture changing? And then I want to drill in and talk about a few aspects of it.

MR. BIROL: Thank you very much, David, and thank you very much for inviting me to Brookings. So it is very nice to come back after a few years.

So I would like to leave the time for discussing with you and with your colleagues here at Q&A, but perhaps I will make one observation such as you did, and second, two important data points, important developments in the recent times. I want to highlight this, too.

So when we look at the future of energy, we see four major upheavals that will shape our energy system in the next two decades or so. What are these four upheavals, as we call them?

Number one: China. China is changing -- I'm talking about in energy terms. So is the Chinese energy system and so is the implications on the global markets. When we talk about China, we told (sic) China, remember, lots of coal, oil and so on, but recently, David, the Chinese Communist Party Congress, it is the most important instance in the Chinese system, decided that China will push the clean energy.

And President Xi, in his final remarks, a very long manifesto in the closing session of the Chinese Communist Party Congress, they summarized this under the motto of Making the Skies of China Blue Again. And today, China is the number one in terms of village, number one in terms of solar, number in terms of electric costs, number one in terms of energy efficiency, number one in terms of natural gas demand flow and many things.

So China is changing, and we will see the implications of this on the markets as we have seen for the oil markets, oil prices, for the coal, CO2, et cetera. This is number one. China is changing and moving to the clean energy direction -- cleaner energy direction.

Number two: Renewable energies, especially solar and (inaudible) are getting cheaper -- and cheaper and cheaper, and they are becoming the cheapest source of electrics, the generation in many emerging countries as well in terms of generation cost, and we see a boom of solar followed by wind.

There are challenges coming from this in terms of integration done in the system, but the cost is coming down. So compared to last time when I came to Brookings, perhaps six or seven years ago, when I compare that time with where numbers are now, renewables are not anymore a dramatic story. It's a business now, mainstream business. When I say renewables, it is solar and wind. So this is the second transformation in my view of the dimension of the next decades to come.

Number three: United States. Almost seven years ago, seven years ago in our (Inaudible) we wrote something in the initiative summary seven or eight years ago. Dakango would remember. He was in our -- on our board.

We said a silent revolution is taking place in North America, talking about the shale evolution. And it was very silent. At that time, I even made a joke -- nobody

laughed (Laughter). I said normally, the evolutions happen in South America, but this time it's happening in North America (Laughter).

MR. VICTOR: We laughed this time.

MR. BIROL: This, I thank you very much. Very kind of you (Laughter). And this silent evolution we have foreseen, shale became very loud now, and our numbers show that the U.S. will be the undisputed leader of oil and gas production growth many years to come.

Tomorrow, we are releasing our fourth year gas market (inaudible) focused and the numbers are very, very impressive, but I can't tell you that. So this is the U.S. This is -- the U.S. is coming, and the implications of this will be felt from the trade floors to geopolitics of energy, from geopolitics of energy to the implications for the other exporters and also, many importers, gas and oil importers who even -- will not ever import one BCM of American gas with benefit from this. If you wish, I can explain that. So this is the third dimension; U.S. oil and gas and U.S. becoming the undisputed leader of oil and gas production growth for many years to come.

Fourth and the last that dimension is electrification. Our energy system is being electrified. What do I mean with this? When we look at the numbers, which we do; you know, we make our hands dirty with data, energy demand is growing. But electricity demand is growing two times faster than the energy demands.

So we are seeing that the all -- in the buildings, in the households, in the industry sector, slowly but surely in the transportation sector, share of electricity also aggravated by the digitalization of our social lives, electricity demand is growing very, very strong. And this has measured implications, and this is coming mainly from emerging countries.

In the United States, or we can put it -- I don't want to talk about the

United States much, but let's talk about Europe. In Europe, we discuss a lot, in Brussels, especially, should the share of the renewables be 37 percent, 33 percent and so on (Inaudible) at this point of the current European agency generation.

But India in the next 20 years is adding to its capacity one entire Europe. India is adding one Europe, we call it. So this is so important -- what should be done that (sic). The U.S. -- you are discussing the coal and gas and renewables. China is adding one United States in the next 20 years.

The choice technology -- choice of China, India will be extremely important. So electrification is coming from there, and what kinds of decisions that they will make in those countries will look in our technological system, because as we all know, whether it be the power plant, it is a lifetime of 40, 50 years. So the choice and the technology will be very important there.

So this electrification of our energy and economics is really important. To sum up, we see four major appeals: China is changing; going into the direction of cleaner energy systems. Second: We see that the renewables, solar and wind especially are becoming cheaper and can be competitive in many cases with other traditional energy sources.

Third, the United States is set to become the undisputed leader of oil and gas in many years to come. And fourth is the, as I mentioned, the electrification of our energy systems. So these are the four strategic dimensions for the next 20 years to come.

Now before going to the Q&A, I want to mention to a bit -- written very recent data points which I think are very important to underline. One is on the climate change front. Carbon (inaudible) emissions are the most important greenhouse gas when you look at the energy sector, and which we do, in that we look at every year very

closely Co2 emissions.

And we were very happy -- the years '14, '15 and '16 because global Co2 emissions did not increase. They were flat in '14, '15 and '16. When you look at the history, emissions always increase if there is no financial crisis. In the recent past, it decreased only in the year 2009 when we had the financial crisis. Except for that year, every year it increased, but '14, '15 and '16, it was flat.

We were very happy that we said at least it's not enough to reach the targets, but at least there is -- the situation is flat. But we added 2017 numbers and we were very disappointed, because once again, once again, global emissions increased. In '14, '15 and '16 they were flat, despite the very strong economic (Inaudible) -- economic grew, but the emissions were flat. But '17, again, it increased.

And I can tell you something; I don't have the good news or bad news. The largest -- and some countries increased and some countries decreased in the world. The largest decline of Co2 emissions in the world came from the United States. That's on the records. We just look at the numbers. This is something that I think we need to see, and it is something important to underline and look behind the rhetoric beyond the discussions.

The last data point is something about the subject which some of you or have followed since several years, electricity access in developing countries. So when we have started, we look at every year in the -- at how many people in the world have no access to electricity. We are they, these people?

If you take your problem seriously, you first measure it. We measure every year what is the development, whether there is progress or not. Since we have started to measure this data when we started first, there were three major areas where we have seen the problem at each country's areas. China, India and Sub-Saharan Africa

starting from the 1990s.

China, around the year 2000, fixed their problem. China completely went frontile and having universal access. And now, as of April, 2018, India fixed its problem in India. Now, all the villages have access to electricity. It's a big thing. In my view, it's a very big thing. India brought electricity to almost half a billion people in a very short period of time.

A big part of the success, the credit, was the Prime Minister Modi and his government. They took a very serious angle. And now the problem is left which you're stuck with the China, India, Africa problem. It is now left only in Sub-Saharan Africa where we have still (inaudible) amount of people, two out of three people who have no access to electricity.

So is a data point I was very happy to -- because we work very closely with the Indian government, with the new IEA, I should say, that India has now universal access, all the villages in India have universal access to electricity. So these are two data points in the Co2 emissions and also on the side of the access to electricity I wanted to mention (inaudible).

MR. VICTOR: Well, thank you very much. So this is an enormously helpful overview. Let's take a few minutes and talk about each of these upheavals.

MR. BIROL: Yes.

MR. VICTOR: And the data point. You can start with the older industry, the oil industry.

MR. BIROL: Yeah.

MR. VICTOR: In 2014, oil prices came down very quickly. People started talking about lower for longer. Then people started talking about lower forever. I live in San Diego, and I get to commute between Washington and San Diego, which

means I get to fly over the Permian Basin in West Texas on a regular basis, and I open the window and look down. It's just -- every time you go over, something is different.

It's an extraordinary change that's happened in the United States. Has this transformed where prices come in the global market, and so therefore, we're basically lower forever?

MR. BIROL: I wouldn't say lower forever, as we see it is not --

MR. VICTOR: I know forever is a long time.

MR. BIROL: Yeah, forever is a long time. Exactly. And we don't know if we need oil forever. We may need oil for several years to come, but forever, we don't know. Anyway, I think that the U.S. coming in the picture put -- set a ceiling to how high the prices can go up.

If there is a high price, it will induce more or less oil. Now, we are seeing the second way of the U.S. share coming into the market. Only next year, 2019, 75 percent of the growth in global oil will come from the United States with shale. And if the prices remain high, it will be on these levels. It may be even higher.

But there is one problem there in the U.S., namely the compass of the pipelines. There is a need to, if the U.S. is serious, to export more oil and there is opportunity there. We need to make more investments and we need open the way for new pipeline infrastructure development there.

But the U.S. coming into the picture changed the entire dynamics of the oil market. So therefore, I believe there will be more volatility in the markets, but I don't think that we can see oil prices very high for a long period of time.

MR. VICTOR: Help us understand what that means for the role of OPEC. So last week, the regular OPEC meeting -- there's a decision to increase output. That decision has basically been taken by one OPEC member, Saudi Arabia, working

with one non-OPEC member, Russia.

But does -- when you take a step back from this, looking at the large sweep of history, does the organization you used to work for at OPEC, do they become less relevant, irrelevant, perhaps? How should we think about that?

MR. BIROL: So it is, of course, difficult to talk about -- to say it is relevant or not relevant. But what I can tell you, the U.S. is a major producer. It's a growing exporter, and still many deposits to discover, changed the dynamics of the energy markets, and as such, the established law of the traditional exporters are different now. It did not change.

And to be very frank, David, we are working on a subject now at the IEA with several of the people from those countries given the shale oil coming big time. Given that technologies again on the oil consumer side, such as electric cars, renewables coming, it is high time for the economists -- producer economists which are one-to-one linked to oil crisis, it is now time to diversify the economics.

Otherwise, they may well have some major difficulties as it may be very late. Saudi Arabia now has the Vision 2013. (inaudible) is doing something. But they should -- and Russia, as well. You work on Russia a lot here in Brookings. So if they are not able to change their economic base, they may well make strategic mistakes there.

When it comes to OPEC, the decision OPEC has taken, we welcome any increase in production, whether or not it is good enough or too little, too much as a matter of calculation. But one thing I am seeing in the oil markets in general in energy that I don't like very much, geopolitics is back to energy. Look at Venezuela. Look at Iran. Look at Libya.

So there are several difficult issues in terms of markets and market deficits, and therefore, it is time to for producers to increase the production.

MR. VICTOR: So let's talk about the geopolitics there. You mentioned some countries that are getting the message about reform.

MR. BIROL: Yeah.

MR. VICTOR: Saudi, most interestingly. Russia, for a long time including on the public budget. Some other countries are not doing so well. Venezuela -- Venezuelan output is half, maybe lower of what it was before Chavez took over. There is essentially no serious new investment.

How should we think about when the wheels come off the bus in Venezuela and what those to global markets?

MR. BIROL: I think -- my English is not very good, but I think wheels come off -- I understand what you mean. I think wheels already came off.

MR. VICTOR: (Laughter) Okay.

MR. BIROL: This is exactly -- we are already --

MR. VICTOR: No wheels.

MR. BIROL: No wheels. I don't know if it is -- it is very, very difficult. I mean, it is so dramatic that such a country, one of the richest energy sources in the world, is, in fact, in a position to import oil products. This is really a very tragic illustration, and I hope that it will be restored. But the solution will not go to energy -- just be on energy if you want to solve this problem.

MR. VICTOR: What about Mexico? Mexico has done a tremendous amount on the reform front. We just in Brookings have a paper out in the last 10 days, the first ever systematic public opinion poll of what average Mexicans think about those reforms.

But when you set aside what average Mexicans think, what we see in the presidential campaign and the likely winner is a populist who has said he will reopen the

contracts. He will try to stop corruption. He will roll back elements of the reforms. Is that something that something who looks at the oil markets, and Mexico is a major producer in trouble -- is that something that worries you, or do you think that they're going to sort it out?

MR. BIROL: So I think if, first of all, we work very closely with Mexico. Mexico recently joined the International Energy Agency as a member, and it is the -- in the shortest period of time it (inaudible), because to be a member of the IEA is not very easy to be. There are many, many procedural things; tests, (Inaudible portion) --

MR. VICTOR: Like becoming a member of the Galatasaray football club.

MR. BIROL: Oh, this is something much more important (Laughter). Sorry. Galatasaray is really important. By the way, the Mexican team is doing very well. (Laughter) They even won against Jormus so it is --

Now, we formally -- and I think I wouldn't call Mexican an energy force, because when I look at the depths and the blacks of it, it's a Mexican energy revolution. Oil, gas, renewables, energy efficiency, new technologies. It's just huge.

And I believe all the steps were in the right direction, but these are, as we know, in the energy business. You get the returns not immediately, but a couple of years later, like in the (Inaudible portion) but the investment is long leave time returns. One is the energy; the other one is education. You don't get it immediately. You have to invest and it comes back.

Now, Mexican oil production was declining, and as a result of the opening up, many companies are coming in and putting money and the capital there, and technology. We are expecting Mexican declining again, bottom up and rebound in a couple of years of time. And this will be good for the Mexican people, because it will be income growth for them, and the money in their pockets will be much higher than in

declining terms.

So in my view, it will be a great pity -- the damage will be very bad if, if those reforms are reversed and that capital, that technology is kicked out and we go back to the old times. We talked about the countries a few minutes ago. One should be really careful what one is going to do.

I don't know who will win direction, what this person or that person are going to do, but to turn your backs to the -- getting capital, getting new technologies, opening up and increasing the production, if you turn your back to that and go back to the old times, then you may end up with similar developments as the country we just spoke about.

MR. VICTOR: So what do you do as an international organization when imagine, after the election, Lopez Obrador wins and it's not quite clear which forces inside the cabinet are going to triumph, but he said a lot of things on the campaign trial, and he said he's going to honor those.

We have a president here who said a lot of things on the campaign trial and appears to be honoring them, for better or for worse. What do you do as an international agency in that situation to help Mexico not be the next Venezuela?

MR. BIROL: So David, as you know, you say things before you take the office, and when you take the office, the life may be different. For example, before I became the executive director, my biggest aim was to buy an espresso machine for my office (Laughter). It took me more than one year to be able to buy that espresso machine, because the life is not so easy. There many things that hinders you to date.

So I believe the -- and I hope the common sense will prevail, and the existing contents will be honored. The right steps -- the good steps in the right direction will be kept. There may be revisions here and there. I wish I can understand, but I really

hope that the main direction will not change, and we'll be advising the -- the new government with Mexico, whoever takes the office, definitely in that direction, because one thing we do at the IEA, this is without fear and favor, we say what is (inaudible).

And then afterwards, ask the government to take it or not. We have the same thing with the German government, the Dutch government, Japanese government and others.

MR. VICTOR: We've got one more question about oil, but then I want to move on and talk about some other fuels. One of your upheavals is the rise --

MR. BIROL: Yeah.

MR. VICTOR: -- of America, which is just extraordinary. In this town, that's sometimes called energy dominance. What -- help us understand. There's no question that the revolution inside the United States has generated jobs. It's generated output. Does it generate a political benefit? I mean, can you take energy down and it's out for a drive and do something with it? What do you see geopolitically happening as a result of this upheaval in America?

MR. BIROL: So I should -- I mean, dominance or not dominance, I should say the following.

MR. VICTOR: It's not your word. It's their word.

MR. BIROL: Yeah. So I would say the following. I'm an energy person and I like to talk about all energy issues. But, but let's assume an international meeting summit or a bilateral meeting with the U.S. and the other certainly, whoever this country is.

A U.S. Secretary of State is a major energy importer 10, 15 years ago, and a U.S. Secretary of State is a major energy exporter. I think the second one, Mr. Pompeo today, would be sitting in his chair much more comfortably compared to his

predecessor. This is only what I can say.

And to be very frank, if we talk about gas, leaving the oil aside for a moment, the U.S. production growth is good news for many people around the world. Okay? Including Europe -- very relieved.

I'll give you one number. I was taking this for our press conference tomorrow, and I hope our press officer is not here. But it' a very interesting number (Laughter) because we found out this weekend -- last weekend.

Now, in Europe, one of the major issues is how we will diversify from Russian gas, as you know very well. Why -- first, there were many bitter experiences, as you know, and second, even if those experiences wouldn't be there or even if it was not Russia, to be depending on one single country is not a -- I mean, you want to diversify, not only the gas, but everything you want to diversify in your life at the more -- to be on the safe side.

And Europe took this as a decision as a strategic diversifier from Russian gas, as we all know. But last year, 2017 again, our data shows that while the policy was in that direction, the diversification away from Russia, we have seen the highest Russian exports to Europe; 35 percent of total consumption. It's huge, 35 percent.

And the decision is this way and the -- what is happening is just the opposite. So therefore, I think U.S. energy, it can be the -- not African gas. It can be Norwegians, it can be I don't know. Other kinds -- Australia -- whatever way it is, or Canadian.

So there is a need for diversification of the European energy and gas imports and the U.S. is a very important option here. And I mentioned in the beginning, even if the Europeans don't import one molecule of American gas, when they negotiate the press with the Russians and/or others, the very fact that if they don't agree on the

price, they can't have other options, will make their hand stronger in terms of price negotiations.

So therefore, the U.S. sharing gas helps the Europeans or others. It may not be because you want it to so. I'll make this last -- so as a result of the availability of other options makes the hands of the Europeans stronger when they negotiate the contracts.

MR. VICTOR: So let's talk about gas for a little bit. Churchill said about oil security that security comes from diversity and diversity alone. The picture that you've outlined about natural gas is the -- gas is harder to transport long distances, but now you see this incredible shift from pipeline long distance gas to now more and more LMG gas.

I think the number of countries importing LMG has tripled, maybe more than tripled. It's just an extraordinary transformation.

Has that -- I sense from your comments that that diversity tells us that Western Europe should be less worried about its backbone dependence on Russian natural gas. This has been a question that many people in the United States have worried about for a long time, because we worry about the reliability of strategic partners who are dependent upon Russia. Have they turned the corner?

MR. BIROL: I think -- I mean, you summarized it very well, David. If it wasn't even Russia and other countries, it would be risky to -- 35 percent of your gas comes from one single country, if it's a tiny country. And Russia isn't a tiny country. We know that.

So therefore, it is even more risky. So therefore, even in my view, it is now time the European and the U.S. policymakers should come together and discuss seriously how they can make the most out of this. I think it is the -- I believe the gas can make this recently the widening Atlantic a bit -- and bring it narrower, in my view. And it

should be good for the U.S. and good for the Europeans.

MR. VICTOR: Let me tell you -- ask you about a particular project that's just -- this week around the edge is the World Gas Conference, BP and its partners are celebrating the opening of the Southern Gas Corridor. This is a project that brings gas from Azerbaijan across ultimately Turkey and into Europe.

Does this -- you're Turkish originally. Does this bring Turkey closer to Europe?

MR. BIROL: I think this is a -- first of all, this project is a wonderful project, because it will help to bring the (inaudible) gas to Europe and it helps the diversification that we were talking about. And I believe this project coming from Azerbaijan to Turkey and to Europe will be an important bridge -- another important bridge between Turkey and Europe, which is very much needed and good for the Turkish and the regional gas security.

MR. VICTOR: What -- help us understand the outlook for gas globally. You think about the three major fossil fuels. Your projections show demand for oil rises. Your projections show that demand for coal, a little bit rises, but frankly, the Chinese coal consumption is basically flat. The big growth now is in India, not in China.

But your projections show global growth for demand under almost any scenario rising to an extraordinary level. Even the scenarios that stop -- and this should stop global warming at two degrees see big growth in gas, and then the leveling off.

How should people in the industry think about whether that kind of bullish -- bullish under any scenario, vision of the future is right? Or what's the biggest risk?

MR. BIROL: Needing gas has a bright future, but there are two major, major reasons for gas that it did not grow as much as we projected. Number one: If the price of gas goes up significantly and gas loses its competitive edge which I recall in ever

getting cheaper renewals -- this is the price of gas. If it stays at affordable levels, there will be a huge demand, especially in Asia.

Second, very important in my view and one of the benefits of gas, and one of them is in terms of emissions. Methane emissions are very important, and now you get the methane emissions today, we are seeing a significant amount of methane is leaked to the atmosphere through production, distribution and transportation of gas.

If the gas industry cannot address this methane emission, and this can be -- we have shown in our reports that this can be addressed with existing technologies, and half of the emissions can be minimized or unified at zero costs; half of the methane emissions.

And this is a huge thing, and I can tell you, to put it in context, this half of the emissions from methane that we can completely get it of at no cost is equal to the emissions coming to two-thirds of the coal plans in Asia. Just let me repeat it to you, because the (inaudible) may not be very clear.

The methane emissions today is a major problem coming from the gas, and half of the methane emissions today can be mitigated at no cost. And this at no cost mitigated half of the emissions is equal to the emissions coming from the coal plants -- two-thirds of the coal plants in Asia. And this is a major hallmark for the gas industry, so they have to make sure that the prices don't go up too much, and the second -- and this, the methane issue.

MR. VICTOR: So those are two pretty big risks when you look at the global picture --

MR. BIROL: Yeah, yeah.

MR. VICTOR: -- and your own projections show demand rising consistently.

MR. BIROL: Yes.

MR. VICTOR: So it sounds like you think the probability of those risks is low.

MR. BIROL: Yes. We assume that they take the decisions in the right way, and the industry will address it, because there is one big advantage of natural gas. It is the reason why today in Asia, it is very, very strong; namely local pollution.

You hear when we talk about the land -- we talk about in land term issues, the first thing that comes to mind is the climate change, but there is another one -- local pollution. And today, in many countries, they use gas in order to reduce the local pollution in the cities and so to (Inaudible) and practical metrics. It's a measure issue. It's a measure issue. It's a big benefit for gas vis-à-vis coal.

MR. VICTOR: Let's talk about climate change for a little bit. You mentioned in your opening remarks this inconvenient fact. You said it's facts, not fake news.

MR. BIROL: Yeah.

MR. VICTOR: Real news.

MR. BIROL: Yeah.

MR. VICTOR: It's an inconvenient fact that last years, emissions are 1.6 percent or so, depending on whose data you look at. The largest single increase comes from the United States. That's mainly because gas is almost free in the United States, and so it's out-competing coal, crushing coal, out-competing nuclear, which is not as good news on the carbon front.

That has nothing to do really with a climate policy. It's just reality. How do you think about whether the world is even remotely on track to stop warming not at two degrees, but two and a half or three degrees? One can develop from energy model

scenarios that get you to two degrees. They involve kind of some magic.

You guys have scenarios. Everyone else has scenarios like this. But when you take a step back and you look at where people are really investing, I mean, is this just hopeless?

MR. BIROL: One thing I should say before it's a very good question before that. I will give a later -- long answer to that. But just let me tell you, 2017 U.S. emissions coming down from gas, but also, a lot of renewables in the United States, both solar and wind.

Now, to be honest with you, we look at the numbers. Many governments and many countries make statements and this and that, not only '17, '16 numbers, but we know, David, looking at the projects which are under construction how much of the emissions in the future are already committed. It's (inaudible) because these projects are being done.

And I'll tell you something, in Asia today, 200 gigawatts of subcritical coal-fired power plants are under construction. And it's 200 gigawatts. Okay? So now, looking at those numbers, looking at the political situation, looking at the (inaudible) of the countries and looking at the very fact that if we want to be on track with our scenarios, other scenarios, we have to see a peak of the emissions very soon. The idea was 2020s. And to have a peak of emissions in 2020 -- 2020 is over two years -- two, three years?

MR. VICTOR: But in a long lead time industry --

MR. BIROL: Yeah, yeah.

MR. VICTOR: -- 2020 is over.

MR. BIROL: It's finished. So therefore, I would be just -- would be too diplomatic if I tell you that I don't know -- I am really not very, very hopeful now that we will be able to reach our targets unless there are major, huge technological

breakthroughs.

But this is, I should say, because it is unfortunately the case. I mean, look at the data. I mean, what are we today? How much of the carbon (inaudible) is left? And you look at the old committed under construction projects, the pipe and images come from there, it is not really to model. It's a more subtraction. Addition or subtraction thing, and we can get the numbers. So it is very easy.

But I wouldn't be pretending being too diplomatic to say this and that. It is becoming less and less possible to reach the targets, if there are no major, huge technological breakthroughs or huge political breakthroughs. Both of them don't seem to me very likely in a very short period of time.

MR. VICTOR: Let's talk briefly about both. On the technological front, the first day of the Paris conference in 2015 there was a big announcement to the effect that many countries were going to double their spending on public sector energy related research and development. That would increase the flow of new ideas. Bill Gates was up there saying he's going to do things as well, which he's done.

How are we doing in terms of doubling the spend and making the investment in new technologies much more effective? IEA's own tracking suggests that, you know, in a few areas like solar, some stuff on data centers, a couple of other areas we're on track, but almost everywhere else, we're still lagging. So that's not very optimistic.

MR. BIROL: So we look at every year -- we trust the governments. Trust is good, but control is better, we believe. (Laughter) This is something said by --

(Simultaneous discussion)

MR. VICTOR: Trust, but verified.

MR. BIROL: Yes.

MR. VICTOR: Trust, but control.

MR. BIROL: Yes, control. So we trust the governments, but we still control them. So we look at what they said and what happens. So we look at various and the 38 key clean and energy technologies -- 38 of them. How many of them are in line with the targets that they should go? We have found only three: Solar, electric cars and digital technologies, smart cars. Only three of them, and the other 35 are arguably doing so-so or completely off track.

But in terms of investments in clean energy, research and development, until 2017, for four years they were -- fell almost flat. This is the government and also private security, but in 2017, we have seen a significant jump, 13 percent. Very good.

And again, the biggest jump in terms of the clean energy technologies came from the United States followed by some European countries and China.

MR. VICTOR: Does this suggest -- and I want to ask a political question about this. Does this suggest that all of the noise in this town, in Washington, about not doing climate policy and rolling back the previous administration's climate policy, does all that frankly not matter, because on the innovation front, the United States is still a doing tremendous amount on gas, replacing coal and lowering emissions?

The United States is still doing a front -- a lot -- is all this just noise, or does it have an effect on the politics of climate problems?

MR. BIROL: That's a very good question. I cannot make such political sweeping arguments, but when I look at the numbers, I see that some of the numbers are coming from less -- a good part just -- as it is out of this order, I don't know.

But there is one more political more recently (sic) that I should really say -- I recommend this very strongly. This is the 45Q for the CCUS. There are tax credits --

MR. VICTOR: Yeah, the change in the U.S. tax law that allows people

who build carbon capture and storage projects to get, depending on exactly how the project is designed, a credit that could be worth up to $45 a pound of Co2.

MR. BIROL: Yes. So thank you very much.

MR. VICTOR: I'm always happy to interpret the American tax code --

(Simultaneous discussion)

MR. BIROL: Thank you very much. Thank you very much.

MR. VICTOR: -- when anyone (inaudible).

MR. BIROL: Your English is perfect (Laughter). So the thing I wanted to say is the following: For me, when I imagine if there are no technological big black truths, one of the things I see is that if CCUS can be helpful here because of the following, David.

Why CCUS? Now, you know the entire history of the climate change and all of this -- the debates and the role. In 1987, I don't know if anybody is my age. I think I am the oldest in this -- there was a Mrs. Brundtland, the former Norwegian prime minister.

And no will -- the United Nations secretary general in 1987 asked this former Norwegian Prime Minister, Madam Brundtland, to make a report called Sustainable Development. This concept came for the first time, and her report was the first -- the Bible at that time when it comes to environmental issues.

And one of the most important recommendations was to reduce the share of fossil fuels in the global energy mix. Very clear, 1987. And at that time, the share of fossil fuels in the global energy mix was 81 percent, eight-one. And in the last two or three years, of course, there was a -- I mentioned it, cost of (inaudible) came down. There were lots of green movements, technologies improved. Many countries became much more -- and the (inaudible) became much more aware of the

environmental challenges, and renewables are growing.

This 81 percent in the year 2017, after 30 years, came to 81 percent still. No change (Laughter). This is the reality. So therefore, when we look at the future, fossil fuels will be still, if you want to be realistic, part of the energy mix for different reasons. I can explain this for hours and hours.

And there is one technology which can bring this fact with the climate close together, which is the CCUS. But current appetite in 2017 when we look at all clean energy investments since U.S. investment share was 0.1 percent. Nothing.

So it is the reason I think this new tax credit in the U.S. may be a driver for it, and IEA works very hard on this issue, yes, to (inaudible) with the UK government. We are just before the -- two weeks before the COP meeting in Poland. We organized a high-level with many CEOs, many ministers, with the UK minister to push the CCUS part of the climate change and debate in Poland in the COP meeting.

So I believe this is an extremely important story, that the fossil fuels -- we may see in the newspapers, this is growing through numerous -- they are all growing, but fossil fuels still, they are very stubborn. Economic facts are cheap. Energy is very stubborn, and just don't think that the work doesn't exist of Washington or Brussels or Tokyo. It is huge. China, India, Africa, Asia -- they are the last who are using more energy than others.

MR. VICTOR: I want to ask you two more questions and then we'll put it open to the larger audience discussion. On electrification --

MR. BIROL: Yeah?

MR. VICTOR: Very strong results in the energy modeling community that a world that decarbonizes is a world is a world that electrifies.

MR. BIROL: Yeah.

MR. VICTOR: The world is already electrifying, but the shift to electricity is even more accelerated because you can burn fossil fuels and plants with carbon-captured storage. It's easier to control emissions from a small number of plants run by adults than, you know, millions of millions of sources dispersed throughout the economy. So you can kind of understand why that is.

Your own projections see a shift to electricity. Electricity is growing at twice the rate as the underlying demand for primary energy. This is a super capital intensive business with a lot of risk; possibly more risk now than there has been in the past because of all these changes in technology.

How optimistic are you that the capital is going to be mobilized to allow this pervasive electrification?

MR. BIROL: Now I will tell you something that is again -- perhaps I talked too much and gave too many numbers, but this is -- I cannot -- I have to tell.

So in the year 2017 when we look at the investments, electricity investments, 95 percent of the electricity investments took place in the regulatory environment; only 5 percent in the more market environments. So therefore, we are seeing the electricity companies are more and more need security -- long-term security for their investments. If it is not there, it is very, very difficult.

And as a result of that, we are seeing many changes in the electricity generation side -- in the technology side, especially this 5 percent area. One of them is perhaps only technology that we didn't talk about up till now is nuclear advantage.

A big thing is happening in nuclear advantage. I was thinking in various -- and I testified in the Senate. I told them for me, it is incredible. If I was an American citizen, I would look at that number and I would think twice. Namely, there were years and years that the United States had the largest -- how do you say, the highest nuclear

power capacity in the world, followed by France, where I live.

But in both of these countries, A, there are no significant new bids. Two, many of them, even though they could have lifetime extensions, they are not getting lifetime extensions from the authorities or they think market conditions are difficult.

As a result of that, both of the capacities if the policies don't change, go this way, and in only six or seven years of time, China becomes the largest nuclear power in the world. This is -- for me, it's something incredible.

So China, a country which started only 10 years or perhaps 15 years ago seriously on nuclear, overtakes the United States and France, became the number one nuclear power of the world. And this has many implications. I can tell you one of them.

If U.S.-France-Japan were the countries who were exporting nuclear technologies to other countries -- they take their technologies and so on, and now, when I -- and there is something, learning by doing in the -- you know, in the real world in the technology, bringing the costs down.

But there's (Inaudible portion) how can I say it, for -- if you -- forgetting by not doing. So that means that in life if you don't do it a lot, we forget how to do it, like the bicycle and other things.

Now in that respect, China, by learning by doing, bringing the cost down and the cost of nuclear technology in the established -- like the U.S., Japan and European countries stays high, and we may well see China like we saw in the solar power, one day -- maybe Russia, as well, being the nuclear technology exporting country. So this is a big change in the nuclear domain with huge implications.

MR. VICTOR: And I would say not just China, but also, Korea.

MR. BIROL: Yeah.

MR. VICTOR: I mean, the overnight costs of building a reactor in the

United States now are maybe six or $7,000 a kilowatt, and they are $2,000, maybe less than that in China or Korea. It's not surprising that Koreans are building those four reactors in Abu Dhabi.

Last question: Your projections -- you mentioned at the beginning this important issue of electrification, low income communities. Over the next decade, we're going from having a billion people, roughly, who don't have access to electricity to 600 million or so who don't have electricity, essentially all in Sub-Saharan Africa.

Are we stuck at that point, or do you see the emergence of micro-grids, private sector solutions -- not grid extension, the way China did it or the way the United States did it, as solutions to this persistent failure to electrify the rural populations in Africa, or are they stuck?

MR. BIROL: So I am hopeful for two reasons. One: From a democracy point of view, in Africa now, many leaders -- they may be democratic leaders or not democratic, understood that if they want to have the support of their people, they have to want to first -- very first condition is now to bring electricity to them. This is one. This became a social driver.

Number two: Renewable energies are vast -- they are huge in the -- in Africa, we have 325 days in Sub-Saharan Africa, very direct radiation of sun, even more than Germany. So if you can look at --

MR. VICTOR: Shocking. Normally, I think of Germany as a very sunny place.

MR. BIROL: Yeah, sometimes. Three hundred twenty-five days. Hydro power, huge potential. And wind -- off-shore and on-shore wind. Now, the good thing is, this political and social driver and the cost of -- the declining cost of renewables come at the same time.

Ten years ago, ten years ago, renewables were expensive. There was an excuse, but now it is going cheaper, and I believe we will fix the problem of Sub-Saharan Africa to renewables and also natural gas; Tanzania, Mozambique, Nigeria and the others.

So we will see in Africa something for the first time that we have never seen in the history of energy -- when I look at the U.S., for example, or Europe or China, throughout the economic development process, they used a lot of coal, and then left coal, went to gas, renewables and the others. Look at the U.S. Look at Europe. Look at China, and India is the same.

But in Africa, we may have the universe of access with leapfrogging directly going to renewables --

(Simultaneous discussion)

MR. VICTOR: (inaudible).

MR. BIROL: Exactly. Then going for renewables and gas.

MR. VICTOR: Okay. We have time for some questions. I think we're in a group of three questions. And if you could stay focused on a question as opposed to a dissertation (Laughter), that would be great. Right here. And please say who you are.

SPEAKER: Hi, I'm Brian (inaudible) with S&P Global Plants. My question is about the OPEC deal. Do you think that's enough to stave off this potential supply shack we could be seeing in the next couple of years?

MR. VICTOR: Second question? Right here, please. And the last one is going to be back there.

SPEAKER: Energy efficiency wasn't mentioned (inaudible). What do you see happening? It's driven by regulatory -- you see the world going that direction?

MR. VICTOR: Last one? Right there in the glasses. No, that's fine.

SPEAKER: Hi. (inaudible) Johnza from the Center for American Carbides. I was curious as to what your thoughts are about the maximum share of China's natural gas demand that the U.S. could expect to occupy, or whether China would just benefit from what you're describing of lower prices and -- yeah, thank you.

MR. VICTOR: Okay.

MR. BIROL: So, short answers. We are going to have -- in the oil markets, we are going to have a significant deficit because of Venezuelan free-fall of production. Iran's shipments is a major issue after the U.S. administration's decision.

Libya -- we have a serious problem in Libya. We are losing about a half a million (Inaudible portion) per day there.

So there is a huge deficit there, and the initial decision taken by the producers in Vienna is welcome. However, whether or not it is sufficient enough remains to be seen. We hope to see the producers increase the production even more -- even more, in order to stabilize the markets, and there's this huge looming problem in the oil markets.

Second question about energy efficiency. I'm sorry that we didn't talk about energy efficiency because it is very important. We call it at the IEA the oil gas renewables. We call the energy efficiency the first fuel.

But I can give you one -- tell you how important it is in one recent study we made. It's about air conditioners. Now, again, we always bring it to the developing countries because where do things come from. In the United States and in Japan today, nine out of ten buildings have an air conditioner. Nine out of ten.

In Asia and in Africa, when you look at the -- only 8 percent of the households have an air conditioner. Eight percent versus 90 percent. And with the increasing income levels, we expect they will be air conditioners, and they should buy

them, because for comfort, you need it at the 50 degrees Centigrade.

And the only additional electricity demand coming from air conditioners for cooling is equal in the next three decades -- is equal to the current U.S. plus EU plus Japanese power fields. Just that. You know why? One is the demand is very strong, and the second, a big chunk of the box is air conditioners are very, very inefficient there.

If they were to have the efficiency standards, minimum efficiency portfolio standards as they call it like they have in Japan, for example, this demand would -- will be easily halved. Efficiency is extremely, extremely important, and for -- especially when it comes to electricity. Not only that, also (inaudible) and others, I can talk for hours.

China and the U.S. I think there is a huge opportunity for both countries there. Chinese growing gas demand mainly driven by the, again, air pollution concerns -- making the skies of China blue again, and the United States, I will give the numbers tomorrow to the international press.

Each amount of growth of the (inaudible) coming from (inaudible) in terms of LMG, and I could think there is a very good logical -- I would say a logical marriage and (Inaudible portion). So the logical marriage. How do you say it in English?

MR. VICTOR: No, it's a logical marriage.

MR. BIROL: The marriage is good? Some marriages are logical. You are right. So this is a --

MR. VICTOR: I didn't say that (Laughter). That's fake news.

MR. BIROL: But we will -- all of them?

MR. VICTOR: No, no, no. (Laughter) But I mean, just in thinking about the transport distances, most likely the American LMG is going to go into the Atlantic basin.

MR. BIROL: Yeah.

MR. VICTOR: And then what's going to happen is that cargos from the Persian Gulf --

MR. BIROL: Yes.

MR. VICTOR: -- and Australia that might go to the Atlantic basin --

MR. BIROL: Yes, yes.

MR. VICTOR: -- will end up in China.

MR. BIROL: Yes, definitely.

But I also believe that Australia's coming on board. That will be a (Inaudible portion) Australian growth, and in fact, what we think is -- David, in the next five or six years of time, that will be the champions league of the LMG exporters all about a hundred DCM (inaudible) U.S. and Australia.

These top three will be there, and of course, competition between them as well, in terms of the prices and also, as you already mentioned, many countries are building LMG import terminals. There were five at the beginning of the year 2000 and there are very close to -- soon, there will be close to 50. So 5 to 50 countries will have these LMG terminals.

MR. VICTOR: Just in time for the World Cup.

MR. BIROL: Yeah.

MR. VICTOR: Before we go to the next set of questions, very quickly, there's a trade war under way. Steel is a part of it. The oil and gas industry uses steel like nobody's business. The latest list of retaliatory products from China includes U.S. oil and gas technology and a variety of other exports.

Are you at the International Energy Agency worried about this trade war having a larger knock-out effect in the global oil and gas industry?

MR. BIROL: I think the -- when we look at the history of economic

energy, there are always trade disputes within the countries. There is a looming one, I mean, we are seeing. It will not be the first and not the last, but I can only hope that it will not have a major impact on the energy trades.

And I would hope that the -- it's a very naïve thinking, but energy remains as a business; that is not affected from geopolitics or the trade disputes and the others, but we will see how it goes. But hopefully, it will not have a major effect on the energy work.

MR. VICTOR: Next questions. Right here? You've been very -- exactly. Glasses there, and then --

(Pause)

SPEAKER: Good afternoon, Dr. Fatih. I am Shootie Shookland and I work with the Global (inaudible) Energy Council. I just had a question on -- what do you think is the implication of the drop in storage prices, especially in the (inaudible) industries? And what do you think is going to happen in 20, 25 years or so in terms of the energy mix?

MR. VICTOR: Thank you. Next question. Reed?

SPEAKER: Reed Gatchenu with the United Nations Foundation.

Thank you both for your leadership on energy access issues over the years, Fatih, and also, for this very good analysis. I wonder if you'd get into the speculation realm and suggest how these trends might be affected by carbon pricing, either regionally or globally, and what the likelihood of that is and in what time frame.

MR. VICTOR: Thank you. Last question right here.

MR. FAULKNER: Doug Faulkner, Leatherstocking, LLC.

Your agency has been a strong supporter of global growth of biofuels. You didn't talk about that much, but it was mostly about the utility sector. But could you

discuss that briefly; why you are such a strong supporter and what the implications are?

MR. BIROL: So let me start with, again, brief answers. Storage: The storage costs are falling down significantly. If we want this storage to be a part of our energy system, they still need to fall substantially.

We are in the beginning now, and how it will go substantially down, we need government support. Without government support, if everything is left to the markets, we will not see a drop at the satisfactory level that they will be commercially competitive in the energy system.

Thank you very much for also, your leadership in terms of energy access and electricity access. When it comes to cargo and pricing, I will give very French answers. So what is a French answer (Laughter)? It is a yes, but at the same time, yes. So this I will -- yes and no. Yes and no. Okay, yes and no.

Yes, cargo and pricing is in -- from an economic (inaudible) point of view, it is the best way to reduce the emissions. (Inaudible portion) I think nobody can debate on that. However, there are two problems. This is no part.

To see -- to have an international effective cargo and price where the biggest part of the emissions are coming from -- to see it happening is, in my view, not very realistic where we are now. When I look at the -- I'll go all the countries and China, India, Indonesia, here, United States, Europe -- to see that it is happening in -- carbon price, that without the carbon leakage to have an international carbon price, it is not realistic in my view. Again, carbon pricing is the best intuitive.

Second one is if you want to reach the targets, climate targets, we have to see that the emissions need to peak sometime very soon, 2020, and we cannot wait -- I mean, the carbon price except to discuss how much trade dollars, $10, $15 to be effective currently. It can be in the future, maybe a part of the solution, but we need, in

my view, major breakthroughs if we were to reach our targets -- major breakthroughs in terms of technology or in terms of political breakthroughs. Otherwise, it will not be, in my view, possible.

Biofuels. So biofuels, we are a strong supporter, yes. We are a strong supporter of sustainable use of biofuels. In fact, I would like you to look at our renewable support coming on the 8th of October with a major analysis on biofuel strength, including this potential, and how does it compare with solar, wind and others which are very much talk, which are very much in the press.

We think sustainable use of biofuels can be a very good part of the -- both the funding solutions to energy security, but at the same time, are in lots of problems.

MR. FAULKNER: Are you more optimistic about biofuels -- basically, the biofuel solution, the sustainable transportation or electric vehicles? In the IEA projections, you suggest that we could have 125 million electric vehicles by 2030 up from 2 or 3 million today. That's a huge change.

MR. BIROL: Yeah.

MR. FAULKNER: That seems like that's the revolution, and not biofuels.

MR. BIROL: Yeah.

MR. FAULKNER: Am I right?

MR. BIROL: So electric cars is something -- very, very interesting topic. Last year was (Inaudible portion). We had one million cars sold last year, and we reached three million and three cars. That's one million cars sold. And after -- there are now three million electric cars in the streets of the world, and half of them are in China. The other half, everybody else put together.

It's a big record. We always read about electric cars and your famous

company here in the United States starting with a T, and this is --

MR. VICTOR: They're famous for losing money. (Laughter)

MR. BIROL: They are very famous. I don't know -- Europe we read (inaudible) every day. This is very good. But we at the IEA, as I said at the beginning, try to put things in that context.

These one million cars sold is a record -- a huge record, but it is still 0.8 percent of total car sales, not percent were inter -- not the traditional cars, and only 1 percent or less is electric cars.

They are going to grow very strongly for two reasons. First, generous government subsidies in France. We have 6,000 euro subsidy if you want to buy an electric car. And second, the cost of batteries are coming down. And this is going to very well.

But, ladies and gentlemen, there is a discussion on these electric cars. Does it mean that it is the end of oil? This is a discussion everywhere. And I think this is a -- we think, in fact, I should say, we think it is not at all like this. At all like this.

Not out of -- I asked my colleagues to calculate. Not out of 100 cars was electric, but if as of tomorrow every second car sold in the world was an electric car, so one electric car, one traditional car instead of one out of a hundred, global oil demand would -- will still continue to increase because oil demand growth is coming from trucks, petrol-chemical industry, jets and shipping.

Cars alone is not the only -- are not even the main driver of the oil demand growth. So therefore, electric cars will grow, but it is too early to announce the obituary of oil.

MR. VICTOR: Okay. We will stop writing that obituary. Now, a last round of questions. Right here first. Sir?

MR. CONWELL: Yes, my name is Ted Conwell. I'm with Climate First. And you mentioned that you weren't hopeful that we could stay under the Paris targets unless there "huge technological breakthroughs." Other than carbon capture and storage, what other breakthroughs are you talking about?

MR. GROSSMAN: My name is Mark Grossman. I was wondering, sir, whether you might be able to talk a little bit about the eastern Mediterranean, where it seems to me there's this combination of more gas being found, more politics, and how you see it connected to the rest of the energy system in the world.

MR. VICTOR: And then last one right up here?

MS. RISER: Yes, thank you very much. My name is Mindy Riser from Global Peace Services.

We have all thought that solar might be the great white hope, and yes, I know we want technological breakthroughs. But what do you see as really possible in terms of solar?

MR. BIROL: Okay. So the first question. Except for CCS, what other technological breakthroughs could change the game? I would say another one is the question that our colleagues -- colleague asked or mentioned there in the beginning, the storage.

If we see the cost of storage falls down much faster than the -- what we are seeing now, if it becomes part of the electricity system, this could be excellent news in terms of the -- making the renewable energies and others part of the equation.

Renewable energies are growing, but it is -- their growth is along not enough to bring us to different degrees for Paris trajectory. When with the Paris targets, I don't mean the NDCs, but I mean the -- what is set in targets by many countries.

East Meds. We have huge discoveries there, but discoveries there, but

discoveries made in a -- if I may say, in the wrong time, and there's a lot of gas in the market to develop those resources. It is not very easy in an abandoned shale coming to the markets.

What I expect is Egypt, for example, the Zoa Field. It's a huge, very, very good field, but this will remain in use for Egyptian domestic gas needs. Israel will do the same. And I don't expect in the short-term major exports from Med East to the rest of the world. Maybe in the medium and longer term, but for this not only economic, but there are some serious political challenges, as well.

So in energy, I think this is -- as I mentioned in the beginning, the cost is coming down substantially. Just to give you one example, between 2014 and 2017, in three years of time, the cost of solar is halved. I don't know any other good -- the cost is half divided by two, and we expect it to continue to go down. But still, growth of solar alone is not enough.

And here, the Chinese policies will be extremely important, because today, six out of ten solar panels manufactured in the world are six out of ten Chinese manufacturers. The other four is the rest of the world put together.

Huge potential for solar, but still, again, solar alone cannot solve the problem. Please just remember the following: Our energy problem is not only the power sector. There is the industrial sector. There is the transportation sector. There is the building sector. Electricity is one part of it, and currently, we use solar mainly for the power generation and sometimes for (inaudible) heating in some countries.

Maybe in the very future, we may make much more use of solar, but I hope that the very future is not too late for the imperatives we have today, especially in the context of environmental issues.

MR. VICTOR: Another one implication of what you said earlier is it may

be too late or too dramatic. But it looks like the Paris targets are getting harder to reach.

Just as we're wrapping up, I want to ask you one last question, Fatih. I sense in your remarks today some skepticism about whether the kind of the kind of normal market forces can address these challenges. You talked about carbon pricing; that at some sense, it's going to be hard to figure out what the right prices are. And meanwhile, governments need to go out and get things done.

You talked about storage and the need for -- in addition to all this market-led tremendous advancement in storage, at least some kinds of storage, there is a need for more government support in that.

We were talking about investment in the power sector, and you made the point -- very wise point that the vast majority of investment is in state-owned firms, regulated firms in part because they're larger globally, but also, because the risks are lower.

So, I mean as an economist, does this make you uneasy, because it seems like the solutions here have to be more state-led than most economists would be comfortable with?

MR. BIROL: Now we have -- in the energy sector, we have many challenges, many problems. But some of the problems we have, especially those under the environmental front are so -- and first of all, I should say -- make a disclaimer.

We work a lot with the energy industry. You know, at the IEA, we have perhaps the most active energy industry group with all the oil companies, Exxons, Shells, BPs, the utilities and so on. And you know, I have another hat. I am the chair of the Energy Board in Davos -- World Economic Forum. We run all the energy industries there.

But some of the challenges we have today are so huge and so

immediate -- imminent challenges, there is a -- if you want to address those challenges, there is a need for a collective public answer to that. We are not in a position to leave everything to the market to expect this big answer coming from there.

It can be together with the private sector, together with the energy industry, but I see a leadership role from the public institutions are badly needed here.

MR. VICTOR: That's a very French answer.

MR. BIROL: Yeah (Laughter).

MR. VICTOR: Please join me in thanking Fatih Birol. (Applause)

* * * * *

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