

2025 GLOBAL TOWARD A FLOURISHING FUTURE

POWERING THE FUTURE: ENERGY TRANSITION TO ENERGY ADDITION

Announcer 00:00

To begin the session on powering the future, please welcome the panel on "Energy Transition to Energy Addition," moderated by Vice Chairman S&P Global, Daniel Yergin.

Daniel Yergin 00:38

Good morning, everybody. Welcome to what I think will be an intimate discussion about energy transition and energy addition. It is a very striking time in terms of energy, the sense that, in fact, the world is also discussing energy addition, the sense that net zero targets 45 percent of world emissions are not even covered by 2050 goals receding, and the notion that the energy transition may be not linear, but multidimensional in different rates in different countries, different mixes of technology and different priorities. And that's reflected in our in our panel this morning, we have a number of different perspectives. Amos Hochstein is the managing director of TWG. Before that, he was the deputy special assistant to President Biden. And among other things, he actually is also a very able diplomat, as well as his focus on energy, he negotiated the ceasefire in Lebanon last year. Mohammad Abunayyan is the chairman of ACWA Power and is very much involved in reform in Saudi Arabia. Mohamed Al Hammadi is the head of ENEC, which is a remarkable nuclear power development in the United Arab Emirates. Ana Cabral Gardner is very much a role of a leader and role model in terms of mining, in terms of green mining, and in terms of cost. And Vineet Mittal in the country of India, where the demand for energy is enormous, and he's helping to meet it with being at the forefront of renewable power. So, to begin the discussion, I thought to kind of get us located. I actually asked Amos Hochstein, having been the deputy special assistant to President Biden, on international energy, just how you saw the changing balance between priorities as you dealt with them, between conventional energy and renewables.

Amos Hochstein 02:47

Well, thanks, Dan, and it's great to be back at Milken for me for the first time in a different hat so as part of TWG versus the White House. But it's really an honor to be here with this panel and with you, Dan. Look, I think that over the last several years, what we have to come to terms with, as we went through an exuberance on investment

in the energy transition, is to accept that we're more in the-I think, Dan, you coined it in your article a few months ago, in the energy addition. At the end of the day, the demand for power that was relatively stagnant in the United States or flat, is now growing because of first cloud, then compute now AI, global demand in places such as India and elsewhere is growing. And so even though we've had a massive increase in a multibillion dollar investment and multi gigawatt additions of renewable energy, we are still at a relatively similar rate. The percentage of the overall energy demand is still fossil fuels versus renewables. And therefore, I think as we look into the future, specifically in the United States, where we have to invest in bringing on additional power, we have to be more realistic that a significant amount of it is going to be in natural gas, I think the advent of nuclear, and continue to add the amount of renewables. If we did not add the amount of renewables that we have over the last 15 years, there's no way that we would be able to even keep up with the level of demand today. So, I think, as we-from government perspective, you have to have a view towards simplifying regulatory environments to allow for more investment in energy, I personally think gas, nuclear and renewables, and the building of power plants so that they can be close to areas of water, energy and where data centers would be, so that data centers don't suck that energy away from the grid itself. And then lastly, the investment community, where I today live, is looking at evaluating projects, I think in the same vein, if the government does what it needs to do on the regulatory front, I think there's enormous amount of opportunity and critical need to not only to continue to invest, but to increase the level of investment in this sector. So, I think that's where we'll have to see where the global economy goes and where the US economy goes, as far as demand. But I think that's the frame that I would see in it.

Daniel Yergin 05:35

Well, of course, last year was the highest time ever for wind and solar, also the highest time ever for oil and coal, and it would have also been natural gas, except for the disruption in Europe. Well, you talked about the balance between the two. Mohammed Abunyyan, you're in a country, of course, Saudi Arabia, that is known for fossil fuels, i.e. oil, but your business is renewable power. Tell us how it's developed.

Mohammed Abunayyan 05:59

Thank you for giving me this great opportunity to be with this great audience, these panelists. You know, Saudi Arabia is very well-known that it is, you know, oil producer. But Saudi Arabia, it's not very well-known that it's the best example in the world today, and they have done so much that nobody else in the whole world has done. Being from oil producer to the best energy transition implementation, not talks, not strategy, not incentives, without incentive, without economical impact, it's a positive impact to the economy going through transition in the same time is energy security. And that is what is very relevant, Aqua power, since inception in 2004 until today, we have over 75 gigawatts in operation.

Daniel Yergin 06:57

And are you saying that it is-part of the reason for ACWA Power is energy security?

Mohammed Abunayyan 07:03

No, it is because we deliver value. ACWA Power is the only company, I will tell you, in the Arab worlds, in Africa and Asia, where it has put one very clear target: affordability. And if you see the 14 countries we are in today in desalination—because we are the leading the world in desalination, by the way, but also renewable and gas to power and now green hydrogen, that we are the lowest producer and reliable and sustainable and secure energy in these 14 countries, and that's the reason we are welcomed in these 14 countries, not because political will only. No; by delivering value, training the youth, making this knowledge and transferring technology and capacity-building, and delivering the best value. And that's the reason Saudi Arabia today, I'm sure that you know, it's public information, 50 percent by 2030 will be renewable, green energy. And you could you believe in the biggest producer of oil and earth is going to be 50 percent by 2030? Every year they are contracting 20 gigawatts.

Daniel Yergin 08:22

What's the mix between solar and wind?

Mohammed Abunayyan 08:25

As you know, the resources of wind in Saudi Arabia is less compared to the solar. As we speak now, Ministry of Energy is doing something nobody else again done it anywhere else in the world. They are mapping the whole country resources in 16 months from now, you will have 100 percent transparent resources. The estimates of our resources is over 500 gigawatts of renewable, and 1/3 of it, possibility will be wind.

Daniel Yergin 08:58

So, let me ask you-that's a very significant achievement. Are there any challenges?

Mohammed Abunayyan 09:04

There is challenges, I'm sure you know, everywhere in the world, there is challenges in Saudi Arabia, like anywhere else. But the most important is not the challenge. We look at, it always challenges for opportunities. And I'm sure you know, the biggest challenge today is supply chain.

Daniel Yergin 09:20

I was going to ask about that. I think that's a theme that will run through this whole panel.

Mohammed Abunayyan 09:23

Yeah, but the supply chain is today is a huge challenge. But what Saudi Arabia has done with reliable partners that they made this challenge to be done. Saudi Arabia will be exporting solar panels by 2027, 30 gigawatts. There is a production going to start in 2027. We are going to produce another four gigawatt of wind, and we are going to be a net exporter of supply chain to the world and the renewable to the world. The same thing we are doing now with electrolyzers. Electrolyzers for green hydrogen will be produced in Saudi Arabia. And you will see Saudi Arabia is going to be leading as they lead in conventional oil and energy, they are going to lead the green energy in the world.

Daniel Yergin 10:16

Well, you mentioned supply chains. And of course, supply chains have also been a very big issue in terms of nuclear power around the world. And I want to turn to Mohamed AI Hammadi. You've built four reactors in the UAE, generally in other countries like the United States or Europe, when you build reactors, the costs are two or three times greater than expected. You brought them in on budget, on time. How did you do that?

Mohamed Al Hammadi 10:48

First of all, very honored to be here with you as the panelists and also the audience here. The UAE success story has been, I think, a great story of, how do you diversify your energy mix between renewable, nuclear and also gas. That is—it's been a great success story, and the fundamentals of that success comes to the, you know, great leadership of the nation to define the path forward for energy security. And that's something where I think nuclear comes in as a key ingredient of that success, of having a base load that runs 24/7. And today we have, as you mentioned, four reactors operational. They provide 25 percent of the UAE energy mix. That's around 40 terawatt hours of energy being produced annual basis. And back to your question on the supply chain. The project that we have here in—we have in the UAE, was properly planned, and it's an international project, it's not just one single vendor technology. These components came 20 percent from the US, from Japan, Korea, Europe, many places that you know to put such kind of a projects together, and on the supply chain today there, maybe I would disagree that there is issues, there is always opportunities to capitalize on. And if you look today at the US, there is very great interest from the leadership of the nation—and has been bipartisan, by the way, subject on the nuclear there is investment and also support from the US government on building those reactors. And we've been also plugging—

Daniel Yergin 12:34

So are you going to build reactors in the US?

Mohamed Al Hammadi 12:36

We are very interested. As Amos mentioned, the current energy demand here in the US, it is on the positive trend of growth, and the last two weeks I have been here in the US, looking at multiple companies and from ultrascalers and others. And as electric engineer, by the way, I'm very excited to see the demand of electrons here in the US is coming up.

Daniel Yergin 12:59

Mohamed, when you first, when they first said, we're going to build nuclear power in the UAE at that point, nuclear was very much out of favor. What was your reaction? What led them to do that?

Mohamed Al Hammadi 13:10

Actually, the question was, if we put a like a white slate, you know, clean slate of white piece of paper, what would be the best energy mix for UAE? Looking beyond it was 2007 that was the planning, 2006, what would be the best energy mix for the nation? You know, being an oil and gas country, and renewable immediately came as a quick I would say quick fix. You could turn them around quickly and get them done. And nuclear was an option to be evaluated. And looking at the economics, supply chain, energy security and all that. And it did meet all the criterias of UAE energy mix. And today— fast forward to today, you know, we have a great success of completing them on budget and on schedule. And if you ask me, that time will you, will I be here in this seat, sitting here looking at the US market? No, that's to be honest. But the opportunity is real here in the US, the demand is real. And the right timing for this build up of the nuclear technology and industry here in the US, I think there was no better time, and this will all be open for another, maybe 15-16, months. If it happens, then it's going to be—we'll give the US a leading edge on these technologies, and I'm very optimistic.

Daniel Yergin 14:24

So, Ana, taking another part of the supply chain, which is minerals, lithium. A year or two ago, we thought the world was going to be in shortage of lithium. Now that's not a problem. What happened to the lithium market?

Ana Cabral Gardner 14:40

There are no problems with most materials. In fact, none of this is rare, and that is what the supply chain sometimes forsakes to see. Which is what is rare is the ability to bring a lot of these materials at very low cost, because everything the materials go to, batteries, cars, you have it, turbines, magnets, has to cost less and less so that we can enable widespreading. But to do so without a race to the bottom, which is the current main issue in the industry. What we're observing is there's superb demand. The levels of the mono unprecedented for the reasons Amos was referring to, I mean, we have a massive growth in energy storage systems. Watch the power grid in Madrid, either because of transmission failures or because of the data centers implementing renewables. So now, what the supply is doing, though, is reacting, I would say in a race to the bottom—

Daniel Yergin 15:44

By race to the bottom do you mean in terms of?

Ana Cabral Gardner 15:46

Of standards, and this is the sad thing, because we're not talking carbon. We're not talking about any of it. And I actually say something that's unusual, if we do the math on carbon, that's why I'm going to say this once and not again, we probably better off with low carbon oil, such as the oil Brazil and Saudi produce. And I'll shelve that—

Daniel Yergin 16:06

No, no, don't shelf that, I think people have been very-

Ana Cabral Gardner 16:09

It's a big deal. But—so the carbon map is not working, because we're seeing things in terms of race to the bottom, such as diesel generators powering processing facilities for nickel, lithium, cobalt [inaudible]. I mean, women going into or children going into mines without helmets. So, because the materials need to be cheap, there's a short cutting in capex that's just obscene, and it's not conducive to an energy transition. So, the question I ask myself sometimes is, is this what this is going to become? Might as well stay as we are, because the current status quo has standards. If we migrating into an energy transition where there's absolutely no standards at all, where it's just some, you know, artisanal giant mining pit throughout regions that don't defend themselves, we'll end up worse off.

Daniel Yergin 16:59

So, first, to go back to that question, what happened to the lithium market? Why is prices were up ther now they're down there?

Ana Cabral Gardner 17:06

Because lithium is not rare, it's just abundant. So there's lots of supply.

Daniel Yergin 17:10

{Inaudible] It was the supply response, is that -?

Ana Cabral Gardner 17:13

Supply response, but then the interesting part, and this is, this is actually you hit the nail in the head. The initial supply response was with high cost materials, that's okay, the secondary supply responses with low cost materials, and we're good, because we beat the lowest of the low given the industrial operations, low cost we execute a sigma. However, when you start looking at competition, then you see things like, well, there's two sigmas coming out of certain nations where's a big artisanal, illegal mining operation, so no one's paying attention, and these very materials end up everywhere, in cars over here in California. So I think these are the questions we should ask ourselves. Are we migrating to a zero standards, to a complete race to the bottom and ignoring what is happening?

Daniel Yergin 17:59

You pose the question, what's the answer?

Ana Cabral Gardner 18:03

Well, I think the answer, in my view, is, this is where the government ban could be very well used. You know, why cost taxpayers zero. In good Margaret Thatcher way, this is not a subsidy you need to give. It's simply just ordering the supply chain. In other words, and call a spade a spade, if these are blood minerals, these are blood minerals, right? If these are low cost materials produced fairly industrially—and I'm not devoid of nationalities, there are people all over the world who do this very well in every location, blood minerals are blood minerals in decently produced minerals with a minimum of standards are decently produced minerals of a mineral standard, because the oil and gas industry, that's fantastic with standards, right?

Daniel Yergin 18:50

So, Mohammed and Mohamed have both talked about green, low carbon. I think you've also tried to make your own operations green or semi-green?

Ana Cabral Gardner 19:03

Well, look, we are, let's say, an anomaly, and I don't like to talk about it, because what I said is we, we have materials that are zero carbon, we don't have a tailings dam, we don't use drinking water, we don't use toxic chemicals, we invest in millions in innovation just to end up at a location in terms of occupying a space that's basically just us. So I can come to panels like this and say things like that. However, I'm getting to a point now where I'm thinking, well, this whole industry is not going that way. So I feel almost like an extinct animal in a certain manner, because nobody cares. Everybody cares about cost. So what we doing now is solely based on purpose,

because we got extra cost. Even though I'm the lowest cost producer, I could be even lower of the lowest of the low if I were not spending what today is about \$40 a ton on sustainability. So, this is the thing, I think the industry needs to think about, well, we're going to be fine always. That's why I'm saying this. However you got throughout some of the traditional mining jurisdictions, companies are just dying left and right. Places like Canada, Australia, where mining was done traditionally, where it's high cost, companies are just not making it.

Daniel Yergin 20:23

And you're only in Brazil, right?

Ana Cabral Gardner 20:25

We're only in Brazil.

Daniel Yergin 20:26

And when did you start the company?

Ana Cabral Gardner 20:28

The company started 12 years ago.

Daniel Yergin 20:30

Right.

Ana Cabral Gardner 20:30

We've been producing for two

Daniel Yergin 20:32

Oh, and how's it going?

Ana Cabral Gardner 20:33

Well, we're one of the lowest cost producers in the world, so we're winning. The point, though, is the industry is not doing so well.

Daniel Yergin 20:41

Right, well, let's turn to India, and I wanted to read two quotes from your Prime Minister to set the stage. Prime Minister Modi said "Global supply chain should not only be based on cost, they should also be based on trust." And then he said, "The need to think both logically and ecologically." How does that affect your operations?

Vineet Mittal 21:04

So thanks, Dan. So he has been the great champion for energy transition, not only when he's the current PM, but we signed our first power purchase agreement when he was the chief minister of Gujarat, and we had set up first 15 megawatt project of India way back in 2010-2011, when he was the chief minister. And what he's driving is based on Indian culture, where we always valued all the natural resources as source of divinity. So we worship sun as a god, we worship wind as a god, and so is water. So, if you look at what he is trying now, is the whole country is driven by making India campaign, where we want to produce locally what we are consuming. Our biggest challenge was that we were over dependent on energy transition, on other countries. In the last five year, India has added 100 gigawatt of solar panel manufacturing. We have added—

Daniel Yergin 22:15

100 gigawatts?

Vineet Mittal 22:16

Yeah, so last week, the government published the data, which is almost 100 gigawatt of module manufacturing, almost 20 gigawatt of cell and government has given performance linked incentive to have the entire value chain from sand to solar panels. So they have, there are four factories coming out for silicon ingot wafer.

Daniel Yergin 22:44

Let me ask you, and also ask Mohammed at the end, can your domestic solar manufacturing? Can you compete with China?

Vineet Mittal 22:54

It's very tough, because what goes in China has taken last 20 years to develop the local supply chain, and some of us are trying—so we are our own company setting up the entire ecosystem in a same city. We are going for all the bill of materials, and going right from the silicon ingot wafer, cell and modules. So if you can do all of that, probably you can compete with China. But China has an edge, and they have invested heavily into that technology innovation, and they have the experience which is currently unparalleled.

Daniel Yergin 23:34

So, let me ask Mohammed Abunayyan, are you competitive? Will your solar manufacturing be competitive with China.

Mohammed Abunayyan 23:41

You know, ACWA Power is not investing in manufacturing, but it's one of our sister companies. And, you know, nobody could compete with China. Anybody will tell you that he could compete with China, then he is in another world. Reality today, China has conquered this business, and they will be doing it forever. Reality that we need to be realistic. If you cannot beat them, join them. You know what we have done, we join the Chinese. And we have agreed with the Chinese that our manufacturing will be at the same cost in China. And, I will tell you this, 30 gigawatt, for your information, it will be the same cost as you are producing in China. And why? Very simple things. Saudi Arabia is different from any other countries on speed, we are putting this manufacturing in 18 months will be in operation from start of construction. Number two, is having youth. You are having work efficient, local and the capability and the knowledge will be local is not important. But also, I'm sure you know, the biggest part of this manufacturing is energy. Saudi Arabia is the lowest energy in Earth cost, and it's not subsidized.

Daniel Yergin 25:05

Right, but let me come back—okay, but in your case, as the prime minister suggests, in your case, India wants to have its own supply chains, very separate from China. Is that? Would that be?

Vineet Mittal 25:17

Not really, because eventually, for wafer ingot we are dependent supply chain from China and even lot of the technology. But—so it's a cooperation, I would say, is a cooperation as well as competition as well as competition. But we have the local demand. Our local demand itself has grown up quite significantly. India has to add up another 300 gigawatt of solar and wind in next five years, and on top of that, we have a huge subsidy program for storage and for rooftop solar, and also to move farmers from conventional power to green power. So that demand is currently huge locally, and ecosystem is getting built. And what has happened in the last 15 years in India, the levelized cost of electricity from solar, wind and storage, or whether it's [inaudible] storage or battery, is almost at

half the cost of coal-based power. So in years to come, actually, we'll be probably as competitive as Saudi or many of the Middle Eastern countries in terms of our electricity cost.

Daniel Yergin 26:40

So what is your generating capacity now from solar?

Mohammed Abunayyan 26:45

So solar, India produces 105 gigawatt, and currently 165 gigawatt of projects are under construction. And when we have almost 51 gigawatt and around 30 odd gigawatt projects are awarded which are under construction. So India is—last calendar year we did closer to 30 gigawatt of solar and wind. And this year, almost work is happening or more than 150 gigawatt projects. So every year India is targeting to operationalize 60 to 80 gigawatt of solar and wind, and that is why the supply chain resilience and having the local supply chain is going to help us a lot. India is not only investing in solar and wind technology, we are going completely backwards. So even say glass, the entire capacity of solar glass in India is smaller than what my company consumes today. And if you combine the entire demand, the glass industry in India would become 10,000 tons per day. So, if you look at across the value chain, we are seeing the investment and government is supportive as well as industry is supportive. And the buyer, industry in terms of the power purchases, they are willing to pay slight premium to have the local.

Daniel Yergin 28:18

So how do you deal with the intermittency of solar?

Vineet Mittal 28:21

So now what you have to do is you have to become very, very good with Indian talent. And what Avaada is trying to do is electron coming from solar or electron coming from wind. You build your own SLM model, and you have to start predicting your generation more accurately. So in India, the solar and wind is complementary in nature. So solar is coming from six in the morning to almost six in the evening. Wind generally starts from three in the evening till two in the morning and goes up to all the way to six. So you have to add significant capacity on pumped storage and battery, and that's where, if your AI platform is good, you can actually make informed power, which is solar and wind, into a firm, dispatchable round the clock green power. And that's what a company like us will be able to provide from 2027.

Daniel Yergin 29:24

So what about India? You have a lot of farmers and land, is land a problem?

Vineet Mittal 29:31

Land is the biggest issue in India. People treat it like their mother. So acquiring the private land has always been a challenge, but we are blessed with lot of desert area. The desert of Thar can power the entire Asia. We have so much of wasteland and desert land, and that's what government has done. Unlike US or Europe, we have actually a single grid. You can give power at any point in India, and you can take out power at any point. So what it means is that I have best solar in deserts, and I have best wind in Maharashtra and Gujarat. So I can actually use the region appropriately and put a storage in the middle, and can give round the clock green power. So this way, actually, it's also helping poverty elevation, energy is inversely proportional to poverty for our country, and what we are also benefiting is huge job creation, because a lot of work is still happening manually. So manufacturing in solar alone has created 100,000 job in the last two years. Construction, another half million job. So you you look at - it's a game changer. It's going to be a trillion dollar market over over a decade in solar, wind, battery and ponder storage.

Daniel Yergin 31:04

So, let me ask the panel, and let anybody who wants to reply to this, if we were holding this discussion two years ago, 40 percent of the discussion would have been about hydrogen. I just heard the word hydrogen, I think once, who wants to talk about where? Okay, at the end.

Mohammed Abunayyan 31:20

You know, hydrogen is part of the energy transition. And nobody will tell you that there will be a total shift. But you know reality today, you know hydrogen is very significant, very important role of the future. Is that going to be 10-15, years, 20 years from now? Yes, where it will dominate the market. Reality, if you look at it low hydrogen, where it's going to be using the natural gas, the biggest challenge is how to store the CO2, and how to keep that in that storage, and how more important and relevant, and that what United States supposed to do, because they always push other countries to do things but they would like also to get engaged and developing technology and solution in how to reuse the CO2. Storing a CO2. It's not the right things to do economically, and it's a great product that could be reused, and there is so many application that could be used. And where United States supposed to do a lot of R&D, and other countries on this regard, in the green hydrogen, where Saudi Arabia today the biggest producer, going to be next year in the world, we are constructing two plants, one in Uzbekistan will be in operation this month, and one in Saudi Arabia, it will be operation in next November, 2026, we are producing 1.3 million ton of green hydrogen. We are producing it out of renewable four gigawatt example in Saudi Arabia, new—

Daniel Yergin 33:00

So you're saying hydrogen still a big deal?

Mohammed Abunayyan 33:03

It will be and it will be a big deal. It will come now and the future. Why? Look at it, you cannot decarbonize today. You cannot do decarbonization of industry without hydrogen. You cannot do it with solar and wind. Nothing. You need hydrogen to decarbonize. If the world going to do decarbonization for the industry, hydrogen will play. Trucks today and busses, you are going to use batteries.? No, you have to use hydrogen.

Daniel Yergin 33:34

Okay, let's-you're in the hydrogen, or trying to be in the hydrogen.

Vineet Mittal 33:37

So, actually, we are setting up half million ton green ammonia plant. If you look at country like India, our biggest challenge is our currency depreciates by 3% because we buy a lot of oil and gas from Middle East and US. And the solution for that is very simple. We are blessed with the abundance of sun and wind we can generate round the clock, green power at the most competitive price. And you take carbon dioxide from the cement plant, steel plant, actually mix the hydrogen and carbon dioxide and make into green methanol or E-methanol. And today, Indian government, Indian Institute of Science, is giving a combustible engine technology for free for all the bus manufacturer and car manufacturer to move to E-methanol. So, what is lacking today, I think, worldwide, is IMO, type of legislation, as you would have noticed last two weeks back, IMO, priced the carbon from 2028, at 350, US dollar, and have now mandate in the shipping sector to have certain percentage of fuel, green fuel starting 2028 onward. And that has suddenly started a huge demand for E-methanol, green methanol as well. Green ammonia, and India has created its own mandate for fertilizer.

Daniel Yergin 35:07

So you're saying that hydrogen is still-

Vineet Mittal 35:10

It's picking up. It's not picked up as much because the carbon market worldwide is not priced. Well, if you price the carbon appropriately, green hydrogen is a very viable product.

Daniel Yergin 35:24

So Amos-

Amos Hochstein 35:27

Look, I think that problem with—as much as someone who pushed green hydrogen on my on our partners in my government role, I think we go back to what I said before. We have to be realistic about where the market is and where the dollars are to be invested and not—we have incentives, government incentives today. Some incentives are carrots versus sticks, or sticks today, more than carrots, but we—green hydrogen, to me, is still something that the market has to prove itself, that there is a enough of the demand at a price that is today. And I think we have to get the scale. I will take Mohammad word for it, that with time, we'll get there. But I think for now, these are demonstration projects more than they are economics. But I think, we're gonna have to look at where, where do we need to invest. And today, I agree with Mohamed AI Hammadi that in the US, the nuclear market is very interesting, and there's a lot there to do. There's a lot to learn from what UAE did when, not just on time, but I think some of the fastest development of nuclear projects in the world. But I think as we now develop here in the United States, I think there's a lot of place, at least we at TWG are going to look into, are looking at the nuclear industry for where there are opportunities for investment here in the United States. I think the supply chain is going to be critical. And I take Ana's point that we are the race to the bottom without a doubt.

Daniel Yergin 36:56

So, let me ask you, when you say supply chain is going to be critical. Obviously, they've gotten a lot more politicized in the last two or three years, and even more politicized now, how do you see this playing out? Is it going to just be more difficult?

Amos Hochstein 37:10

I think we in the political spectrum, we talk with big slogans, and we have to be specific. We can't develop mining in the United States today, from today to tomorrow. So I understand the investment in mining the United States. I think that's a very important thing. I think we should do it. I agree with the administration Secretary Burgum is right. We should invest there, and we should incentivize it. But a greenfield mine will take 14 years at best to get first product out. So we have to do a combined approach of making sure that we have investment into the supply chains worldwide, so that we're not stuck with one supplier of all processed goods, which is China. I think we should—the race to the bottom that Ana is talking about is in our interest to avoid. The more this race of standards goes to the bottom, the more the United States loses. So that's where we have to focus. But I think there is a lot of opportunity here on the investment side.

Daniel Yergin 38:10

So Amos I think, you're the only one I can give this big geopolitical question to. The US is the leader now in conventional energy, ahead of Saudi Arabia, the world's largest producer of oil, natural gas. China is the largest producer of what we could call renewable technologies. How do you see this geopolitically playing out between these two?

Amos Hochstein 38:37

I think it's a danger to our not—yes, people talk about our danger to our national security that we are reliant on China for, essentially for all matters related to renewable energy. And there's a lot of overlap between renewable energy and technology, and some of the components that are needed for renewable energy are also the components that we need for chips and for compute. But it's not just a national security I think as investors, as the economy here, we have to have a diversified portfolio of supply chain, and that means some of it has to come from the United States, and some of it has to come from our allies and friends, so that we have to—it's not about bring is it China or the United States? It's about how do we make a broader circle of friends and allies that we can work with? And that is the reason that I was, you know, working with Saudi Arabia and the United Arab Emirates, about how do we—since we weren't doing the investments, if they're going to do the investments in these areas around the world, that we do them in collaboration, and that has been a very successful model of bringing American expertise in some ways and other things that America brings, bringing our partners who are able to make those investments, whether it's in South America, in Africa, other places. I think that's the secret sauce that we need to have in order to be able to secure our supply chain.

Daniel Yergin 40:03

Ana?

Ana Cabral Gardner 40:03

That's exactly the point. It's the collaboration. Because what do you find Middle East capital in a desire to drive the energy transition in high standards? Because they got the status quo of energy in exceptional, high standards, I would say, in the US as well. Now it's when you think about, where are we going? It isn't about oil versus renewables. No, because everybody agrees that we're going to need AI. For AI, we're going to need data centers, and the data centers suck up quite a lot of power, and this is a consensus. And you look at these grids, you would save money in transmission—look what happened in Europe, right? Europe was down for a whole day. In Brazil, this happens all the time, actually now. So instead of spending money on transmission lines, you can postpone those investments with battery banks. So [inaudible], transportation, you do need these battery banks, either in ESS or, you know, in cars. But ESS is an obvious point, right?

Daniel Yergin 41:04

I think that's another change from two years ago, we would not have been talking about the enormous power needs of Al. And that's certainly, if you look at the balance, certainly in the United States, suddenly natural gas, which people thought was going to decline, is now going to increase for electric generation.

Ana Cabral Gardner 41:19

Exactly, and then I continue on the point, it's exactly what you what we're all saying. We're amalgamating the conversations. Then it goes to, you don't want to race to the bottom. You don't want the energy transition to be something we're not proud of. So how do you do this? You go to low cost jurisdictions, South America. I mean, we're obviously super close to both of the Middle Eastern countries. Now, this navigation is like being the traffic cop of capital, directing investments globally. This is what the US has done so well.

Daniel Yergin 41:49

I want to come back to the investment as a part of the discussion. But just finish a couple more questions. Amos. Do you want us? Is it useful to see this one country is a leader in conventional energy, the other in renewable, China. Is this a geopolitical issue, or is it just a fact of global markets?

Amos Hochstein 42:11

I mean, if you're China, you definitely want to see that, that's a good trade, because we may be the lead—we may technically have the most production, highest level of production of oil. But it's a very diversified economy. You have OPEC countries, plus the United States, Guyana, Russia. It's a very diversified, versus on the renewable side, it's not so I think we have to work together to get to a different place. But again, I think the alliance between the United States and Saudi and UAE and Qatar and others, is critical for what Anna just said. We need to drive capital towards this, but we'll only do it if we don't make it all about the United States. It has to be diversified. UAE and Saudi are high standards, the United States wants high standards. The more we insist on high standards, the more we can have a competitive role to play. If we don't, we will lose out. And again, I think that what we all bring to, what they bring to the table, is SMART Capital, expertise that's been developed. We have a market that is the best economy in the world. We have enormous amount of opportunities for investment for them. So there's a partnership that's there and that's why I think—that's what I think the administration should be focused on. And I think if they do that, if the administration, the government side, does its role, the private capital will be there.

Daniel Yergin 43:39

So we'll come back finish on we'll come back to investment. But two questions from Mohamed Al Hammadi one, you said that between reactor one and reactor four, you learned a lot, and that that affected costs. Can you describe what that process was?

Mohamed Al Hammadi 43:58

Yeah, sure on the development of our program when we did the planning of the project, Is the best way to do those big projects, you have to do them in a repetitive manner. So, as you rightly said, the unit one, compared to the fourth power plant, we built, the cost schedule almost 40 percent more efficient, less rework. And so that dividends came on cost, also on schedule. And that was done through a very start up planning ahead of time to make sure that we do this in the right way. And what we discovered, also from our experience, also the analysis

we've done before, is that if you roll them between units and unit, maybe between 18 months to 12 months, the very easy way of moving people, resources, logistics and a very synchronized manner to make sure to deliver it on time, on budget. And I was personally visiting the site, every month or so, and I've seen the improvement, equality of the efficiency of work, even the labor there is—

Daniel Yergin 45:11

So, it was a 40 percent reduction in cost between one and four.

Mohamed Al Hammadi 45:16

Yes, between one and four. This is something happens, because the talent and institutional knowledge that you develop over those large projects, takes that three years window to for people to move from concrete, from first unit to concrete, the next unit, electric and mechanical work, and that institutional knowledge is very important for such mega projects.

Daniel Yergin 45:38

So I'm sure that you get asked this question every day now, and I'll ask in two parts, were you doing it today would they be all small modular reactors? And the second part of the question is, what do you think about small modular reactors? Because I'm sure everybody asks you that all the time.

Mohamed Al Hammadi 45:54

Yes. And I think you've asked me the same question [inaudible] the last weeks. So, these technologies are evolving. So what I would recommend for such projects you want to go if you have an industrial development, and I think the AI demand was talked about briefly, that demand will require the electrons today, not tomorrow, not in months to come, and that's something making the ultrascalers kind of also compete on that [Inaudible] demand actually is piling up, and you get more and more and more demand coming up, so the proven technologies will be as a priority. Now, looking at the SMR technologies here in the US, there's a lot of advancement happened in the last couple of years. I've been a board member with TerraPower for over 10 years. I've seen the evolution development of those reactors, and it's really impressive. And this goes to both administration, the support to the advancement of the advanced reactors has been tremendous. And the point is, how do you accelerate the development of those technologies? And US to take a leading role in this technologies. I see it happening in a very fast pace, and that's why I'm personally here in the US, talking to demand side, talking to technology providers and companies. And how do we structure those projects to take them from conceptual idea all the way to electrons being, you know, pushed to the grid. And our experience in the UAE of doing this completely from [inaudible], you know, from a piece of paper, gives us that knowledge and expertise. And know how that we kind of bring this knowledge to the US market here, not just capital. We bring our expertise, and know how to be able to manage the risks of those projects from inception, all the way to delivery.

Daniel Yergin 47:43

Do you see ENAC, your company, doing nuclear projects in the United States?

Mohamed Al Hammadi 47:49

We are very interested to be able to make those projects a reality. What I've seen today, in my last two weeks being here in the US and meeting with almost everybody across the demand side, from ultrascalers, technology providers to the you know, middle bankers and the rest of it. There is a serious need, and there is a serious demand. Now, what's lacking or need to happen? How do you structure those deals and manage the risk at each phase of the project? Those projects, whether you go from inception to delivery of electrons to go to five stages of different risks, different owners, different hand holding from risk management, and who will deliver it. Now, we have the good expertise of managing all of that chain, from A to Z.

Daniel Yergin 48:30

So, and I don't know if anybody else wants to come in on this, but do you think it's AI, the need of hyperscalers that that's what's driven suddenly, given this momentum to nuclear in the United States, that wasn't there before, and everybody, it looks like everybody wants to.

Mohamed Al Hammadi 48:49

If I may, kind of chip in. I think almost always had influence at that time. And building up the tripling of nuclear, there was at the COP 28 in Dubai. We had a lot of discussion with multiple countries and also the US government have led, how do we put nuclear and how do we triple it to be able to meet at zero by 2050? that had around 30 nations signing up to that commitment last year, September and the UN meeting in New York, there was around 14 bankers have also committed to see how they can make nuclear—so that momentum have been building up before the demand from ultrascalers. But today, I see a perfect timing of we have the political alignment the capitals there, now picking the technology and meeting the demand and when this technology you want to development, you have to find the right ingredients and everything has to be done right to the high standards, as Amos was saying.

Daniel Yergin 49:45

Mohammed, you agree.

Mohammed Abunayyan 49:47

You know, I would like to mention something more also relevant people focusing at production, reality today, the biggest issue in the United States and many other countries, including India, is the grid, and how you connect to the grid and the distribution Where Saudi Arabia has been, I have to say, long term visionary and planning, were ahead of the grid, you know, always ahead of production and the demand management. If we go to the AI and the data center, we have the demand today almost 30 percent of the energy. In 2030 we are assuming 10 percent of that demand is going to be for data and AI. Reality today, the biggest issues that the world is going to face is not about demand. Demand the huge it's going to be the supply, and how the supply. Countries in South America, country in like Middle East, India, many other places you need to think today about globalization is not local. And my advice here in the state, state is going to be the biggest market in the world, sure, forever, but we need to look at it solution worldwide. If we think local, we cannot make it happen. We need to be global, and we need to make things to happen globally. And the regulation today and the hyperscalers and others, really, they have now to think different. It's not going to be—Today you know, I was here in the state looking for our sister company DataVolt to invest, you know what they told me here in the-my last few trips? Now around here, you are lucky if you get permit in one to three years. You are lucky if you get your energy in five to 10 years. For reality today, this nuclear, you know, thinking after 10-15, years, you know, there is nothing will happen as nuclear, where it will come, where you will produce, where you solve. You need now to look at it long and short, medium

Daniel Yergin 52:02

I think the point. So you mentioned that 10% of your electricity in five years might be data centers. That's the same number we have for the United States. 10% electricity. Did anybody else want to come in on this? Because otherwise

Ana Cabral Gardner 52:14

Just one more point, has anybody thought about how to mine plutonium and uranium? Because that's what I want to leave the question open, this is the whole issue, right? We got to start at the very beginning. And we talk about the needs—to the beginning of your point—it's a massive demand drive across the board. The point is, where does this start? And that's, I think, where we don't spend enough time on.

Daniel Yergin 52:39

So this is an investor conference, I want to know what you all want to tell investors to do. Amos, you're now an investor, you're no longer a diplomat, you're no longer an energy negotiator, you're an investor.

Amos Hochstein 52:52

Never been happier to change titles.

Daniel Yergin 52:56

Your previous title was pretty good too.

Amos Hochstein 52:58

I'm happy with the with moving on from government. Look, I think for every—what everybody just said, we are at a time where there's so much opportunity, I think we have to separate out what's happening in the United States from the rest of the world. I agree Mohammed, that you have to have a global approach. But what's happening in the United States as far as energy demand, the fact that we have a bifurcated grid system, we don't have Mohammed a grid. We have many grids, and so I think, as investors, what we're looking at, I do think that the AI demand drive is what has brought a new focus on nuclear. I think the reason that we work with UAE during cop in order to bring attention to nuclear is because of that, because until now, we just didn't have a demand growth in the United States. Now we do. So the question becomes, what do you invest in? And I think we have to look at across most of the, not exactly all of the above, solution. But I think as we look at natural gas and nuclear and renewables, we're going to need all three

Daniel Yergin 53:55

What about despite being \$55 a barrel of oil?

Amos Hochstein 54:00

Well, I don't think it plays as far as in the United States. That's not as much—doesn't play as much into the power generation, because we're as a country, don't really use oil in that capacity. I think that we're now at \$59 WTI. It's very difficult to look at increased investment in the short term, until the price environment changes. But I think the—where we go in nuclear, as far as, are we doing, large nuclear power plants, or are we going to or SMRs? I think SMRs is the more efficient way to do it, but we have to crack the code there that we have a chicken and egg if you're building four or five or six SMRs, the cost for power unit is way too high for it to be investable, and if you get to that scale. So how do you, how do you break that timing gap? And I think that's something that, we're going to be looking at, and how do you—what is the right relationship of investors for the power generation to be in the right location, in locations that have access to power, access to water, access to grid, and can you build, and do you have a good regulatory environment to build data centers, or whatever comes after data centers? I couldn't have said data centers seven years ago, what am I not saying today that will be true in seven years? I don't know what is, but it's going to be power demanding.

Daniel Yergin 55:25

Oh, so you don't know what it's going to be in seven years-

Amos Hochstein 55:27

I dont, but its going to be an increase in power demand. That I know.

Vineet Mittal 55:33

See. What investors should be looking at is the off grid solar, wind and battery setup. Now the batteries cost have come 1/10 since in the last 15 years, and now it's very, very competitive. Now off grid solar, wind and battery solution could be cheaper than conventional power, at least in our country, at many location it is, and that would be the best solution for guzzling data centers, because you can take the optical fiber anywhere at a very competitive cost. The issue is on the grid infrastructure. Globally, grid needs almost \$20 trillion investment, and unless every country starts making that investment. Now the last decade was the decade of solar. The next 10 years should be the decade of grid. And grid needs huge strengthening and huge investment. So if I were investor, I would invest into the grid. I will invest into round the clock green power using solar battery and wind and pump storage, which makes it very cost competitive.

Daniel Yergin 56:51

So in the last minute, we have any other advice to investors?

Mohamed Al Hammadi 56:55

If I may, in the US market here, and I concur with my colleagues what they said on grid and also generation. In the last decades, the energy demand in the US have been going down and down and down. Now, the only time now we're transitioning and going upward that will put demand on grid, as spoke about earlier, it also about generation, about infrastructure, supply chain, whatever related to that business. It's coming up, up, up and up and up. So that's why I think that investment is crucial and important. Since we have just one minute last, beware of the what happened in Europe when it comes to investment only on one single source of, intermittent source of electricity out of synchronization from grid. I could talk about that for hours I'm an electrical engineer, that's my, my forte. But make sure you invest in the companies that will have success in this equation. Personally, I see the nuclear technology in the US here has huge potential. There is government support, there is a huge potential, huge demand for electrification, for electrons from those power sources, and that's why I'm very bullish on that.

Daniel Yergin 58:11

So in winding up. And you did mention what just happened in Europe, which is a reminder of the risk. And I think it will be very interesting to see what the real diagnosis of what happened in Spain and Portugal was, and what caused it. Our topic was energy transition to energy addition. And I think one just big takeaway is the focus, maybe

in the past, it would have been on oil. Really, the question for the future is, how are you going to meet the power demands and please join me in thanking our panel for a great discussion.

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