

Announcer: Ladies and gentlemen, please welcome our next panel. Energy, volatility, viability, and what it means for American exporters. Our moderator, Heather Zichal, Senior Fellow, Global Energy Center, Atlantic Council. She is joined by the panelists, Borja Negro, CEO, North America Gamesa, Doug Oberhelman, Chairman of the Board of Director and CEO, Caterpillar, Stephen Poloz, Governor of Bank Of Canada, and Jim Rogers, retired Chairman of the Board, Duke Energy.

Doug: ... The thing that I am disappointed with is [inaudible 00:00:31] age and declining health is doing [inaudible 00:00:37].

Jim: [inaudible 00:00:38] is working.

Heather: Exactly.

Doug: I have so much enjoyed [inaudible 00:00:43].

Heather: Thank you for the opportunity to join you today. We're very excited to have our panelists speak on global challenges and trends in the energy market. Obviously, as we join you here today, we have a very different picture on energy than I think many people in this room would have predicted in 2008. We have crude at less than \$60, we have renewables capturing larger and larger share of the market, the US shale revolution has scrambled traditional assumptions about the global energy picture, and the role of technology and innovation is driving down cost in a nearly yearly basis.

Here to talk with us today about these issues is Mr. Borja Negro, the CEO of North America Gamesa, Doug Oberhelman, Chairman of the Board of Directors and CEO of Caterpillar, Governor Stephen Poloz, the Governor of the Bank of Canada, and Mr. Jim Rogers, Chairman of the Board of Duke Energy. I'd like to start this morning with a question for you, Mr. Negro.

As you are thinking about your business perspective in the wind industry, thinking about 2014, it was a global year for the wind industry. For the first time, you hit the 50 gigawatt mark. Obviously, very exciting. As you think about the future, where do you see some of the opportunities?

Borja: Thank you for the introduction. I think the biggest challenge the world has in terms of energy is probably giving access to electricity to those 1.2 billion people that still [not have 00:02:25]. At the same time, we need to provide a response to all those countries with very fast-growing middle classes, and that our demand in growth of energies of around 15% to 20%, and finally, we need to fight climate change.

For us, a renewable company, we think a big part of the response to that and the markets that have those needs are India, a lot of Asian countries, some countries in Latin America, and that will be the focus of our efforts. There are opportunities there because those countries and the world today needs energy that is, first, competitive, and renewables is very competitive. Wind is, in some regions, the most competitive source of energy without any subsidies.

Also, we need price [inaudible 00:03:21]. We know that the cost of fuel in wind or solar will be zero for a 25-year or a 40-year facility. We also need to protect the environment, and we also need speed in the installation of those energy facilities. A wind farm can get built, a 200 mega wind farm, in just eight or nine months. After the start of construction, it will be generating electricity. I think that's a great opportunity for wind. It's a great opportunity for renewables to respond to that [inaudible 00:03:54].

Heather: Switching gears a little bit, so much of the conversation in energy policy circles is about the price of crude and what all that impacts. Mr. Oberhelman, how do you see the decline in price of oil affecting your business?

Doug: I'm sorry, I can't hear you over here very well.

Heather: Sorry. How do you see the decline in the price of oil affecting your business?

Doug: Thank you. I very much appreciate being here with you and the panel as well. The price of oil for Caterpillar has been a real headwind, and it will be in 2015. We have an energy and transportation business segment that's about a \$22-billion segment, and our oil and gas piece of that is an important part of that. It's not the biggest part of that by far, but within that, we break down into oil supply, which is land-based well servicing, pad preparation for oil sites, drilling and fracking.

Then we have a fairly substantial gas piece as well which is primarily gas compression which, as you turn on your flame on your stove, the pressure behind that flame is what our equipment does. It supplies a pressure through the pipelines from the well head to the point of use. In our case, this year, it's about oil fracking.

We lowered our forecast about 10%, about \$5 billion, 2014 over at '15, and about half of that is oil fracking. We do that in two ways. Site preparation. We use a bulldozer, generally, and a motor grader, and maybe one other piece of equipment to prepare a flat site. They typically put gravel or some kind of smooth surface over that, and they come in and do their drilling with a fracturing complex which includes a number of very large Caterpillar engines and pumps to supply high pressure down the hole to actually frack and break up the shale.

Obviously, as that business has plummeted, so have our sales to the frack sites, and that's primarily the way it helps us.

The other side of this, however, is every one of our products uses diesel fuel. The price of diesel fuel has declined by about half over the last year which is a benefit to a lot of the users of our equipment. I think that [inaudible 00:06:17] is a major stimulus to the world, particularly to the North American economy that will work its way through, eventually. We're seeing some of that in some places. For us, it's a double-edged sword. It's a little sharper sword at the beginning. This year, later on, it'll be the other side of that.

Heather: Picking up on that, Governor, from a Canadian perspective, how do you think about the changing price of crude and how your economy is adapting to that?

Stephen: Well, sure. Thanks. I'm delighted to be here, by the way. It's a great conference. This drop in oil prices is a very significant shock for the Canadian economy. Oil exports constitute about 6% of our GDP. What's happened in the last six months is the value of those exports had been cut in half, so it's like a 3% pay cut for the whole country. Of course, it's not spread evenly, at least not at first, but eventually, it spreads almost everywhere, either upstream in the case of cancelled investments, as the sorts of things that you're talking about.

Something like a third of all the investment in Canada each year is in the oil and gas sector, and those companies are cutting by around 30% or 40%, that kind of thing, so it's a very big hit to the bottom line. Also, downstream. As there are layoffs in that sector, somebody who is planning to replace their vehicle this year now won't replace their vehicle. Their layoffs are related to that in various other supply sectors.

The good news though is that we think it's a very front-loaded and one-time kind of shock. It sets up adjustments in the economy that there's a lot of positives that come a little bit further down the road. That's what we're looking for. Actually, starting in the second quarter, we think the positive will be more important than the negatives. Certainly, in the second half of this year, this shock should be fully behind us.

Heather: We've heard about the impacts of changing crude prices and low crude prices. The other area and segment of the economy that is really seeing a lot of transformation is the utility sector. Everybody is talking about what's the new business model for the utility sector in the future and what's driving that. Can you speak to some of that, Mr. Rogers?

Jim: Sure. Heather, thank you very much. I'm delighted to be here. I would start by simply saying that shale revolution in the United States, the falling cost of

renewable, solar and wind, are really transforming how we generate electricity in the United States. If you go back five years, it was almost 50% of electricity came from coal. Now, it's about 39%. You see an increase in renewables, increase in gas, and nuclear is holding steady at basically 19%. While it's only 19%, it's 64% of our carbon-free electricity, so carbon climate change is going to play a key role.

The transition is going to be driven by a couple of key facts. One key fact is that virtually every power plant in this country except hydro will be retired and replaced by 2015. We almost have what I'd call a virtual blank sheet of paper, and so the question is what do we build? What we build has implications around the world, is other economies, I think of Europe specifically, are going through similar transitions, but probably a little more emphasis on green than there is in the US at this moment. This 2015, need to retire and replace is really going to drive significant investment and change the mix from where it is today. I would predict that coal will continue to fall, gas will rise, although we have to be careful to avoid all gas all the time for a variety of reasons.

The second thing I would say is the demand for electricity. Now we're living in a world, what I call the new [normal 00:10:30], where growth is only 2% to 2.5% in the US, the economy, but you see a decoupling of the demand of electricity for the growth in the economy, so we see the demand is basically [flattish 00:10:42] to maybe declining in the future. That has an implication for the regulatory model of utilities in the US.

I think at the end of the day, you're going to see a fundamental change in the regulatory model. It's going to happen state by state in the United States. As a consequence of that, the role of utility will not just be a seller of kilowatt hours as they've historically been, they will be making a significant investment in energy efficiency or productivity [gains in 00:11:13] the use of electricity, significant investment in converting the grid from an analog to digital grid so we have the capability to handle solar on the rooftop.

Ultimately, the role of the utility, and they'll be compensated for this, is the optimization of electricity. The use of electricity all the way from solar on the rooftop, central station plants all the way to the device. Because we're fast-moving into the world of the internet of everything, every device will have an internet address. That's the new world that we're moving into.

Heather: Mr. Negro, obviously, Mr. Rogers has painted a really interesting picture of both flat demand, but also greater potential for renewables. As you think about the impediments to increasing wind power, what are your primary concerns? What do you see as the biggest impediments out there?

Borja: Probably, if we think especially about foreign markets, about export, the primary concern is regulation. Sometimes some markets are very protective with local suppliers or require a lot of local content. Sometimes there is unstable policy which links with lack of financing or expensive financing, and [inaudible 00:12:43] plays a key role in trying to help those projects to happen.

Second, we need to keep lowering the cost of energy or renewables. It's gone down about 50%, 60% for the last five years, but we need to continue that trend through innovation. Another challenge, a big challenge, is the lack of transmission. We're talking about all those rural, remote areas where people don't have access to electricity and where the national grid doesn't even reach those villages.

How can we build energy facilities? How can we electrify those villages without a grid? Well, we're working on that, obviously, because the challenge is great, but the opportunity is phenomenal there. For example, renewables can be combined with storage systems so that we can have even off-grid systems and we can overcome that lack of transmission.

I would say those are the main challenges. In the past, we've been very linked to the price of oil. That trend is changing. We're less and less dependent on oil fluctuation. [Seeing 00:13:57] the last six months or eight months where the oil has dropped by 51%, if you see an average of the publicly traded renewable companies, they have almost not been affected. There's a variety of reasons for that, but in reality, electricity generated by oil is a very small part of the market, 5%, and [inaudible 00:14:20] oil would need to be at \$23 to compete with wind. I think that's an important trend.

Heather: Mr. Oberhelman, obviously, building off of the discussion around renewables, how does your company think about and approach other types of energy sources, including renewables?

Doug: We have several things going on. I just visited one of our proving grounds out in Arizona where we're taking a mining truck that will haul 250 tons of ore coal aggregate, whatever it is. These are typically used in very big mines around the world for all kinds of commodities, and it's always been a diesel engine, so burning diesel fuel. We now have a lot of, at this stage, late experimentation, almost commercialized conversion kits to LNG.

There are obviously a huge demand for that. The problem is, of course, we just lost the edge with the fuel price dropping in half, but there's still a demand for many miners and sites around the world that have their own natural gas, and many do it. It's easy to refill. That's an exciting program, and we're going to invest in that because long-term, that will pay off.

We're also doing an awful lot of work in one that's fun. It's not a big market, but we've supplied standby generator sets fueled by diesel with a solar panel to villages in Africa and places where there's a lot of sun. Maybe at night, obviously, there's no sun, there's not a battery storage, so the diesel kicks in. We can supply electricity to an awful lot of people very inexpensively and in a very environmentally friendly way.

I'd say the other area that's really the biggest that we're working on is something that is known as combined heat and power around our big reciprocating diesel and gas engines and around our industrial gas turbines. A typical reciprocating engine or a turbine is somewhere between 40% and 50% efficient is all.

That's about as good as it gets, but if we combine harnessing the heat loss off that, you can imagine a turbine, which is essentially a jet engine, and the amount of heat it generates, we harness that heat, we more than double the efficiency of that package. That's a way in which a lot of utilities are going today and a lot of other big power users are going. We can really step up the efficiency of that equipment that time. There's an awful lot of demand for that around the world.

Then we're able to burn all kinds of alternative gases that are available. Landfill, for example. A lot of methane that's going to escape anyway. We can harness a great power. We have quite an alternative program going a little bit differently than you'd think about renewables. Typically, solar and wind.

Heather: We talked about all the people on the globe that have lack of access to energy. We talked about some of the technology that Caterpillar can bring to bear to allow and to provide energy for those who aren't hooked to the grid. I know, Mr. Rogers, you have been giving a lot of thought to how do we tackle this energy challenge, how do we bring power to those who don't have it today. You're working on a book. Can you provide any insights that you've [inaudible 00:17:41] from your work there?

Jim: I think there's a number of impediments of bringing electricity to the 1.2 billion. Probably the top impediment is government policies in countries. Most of the countries that have electrification, need for electrification in the rural areas, have stayed on utilities. They put tariff on new equipment.

If you're going to bring Caterpillar gen set in, there's probably a tariff on it. If you're going to bring solar panels in or solar [lanterns 00:18:14] in, or if you're going to build a microgrid. All of that, there's the need for governance around the world, especially in the low-income countries, to basically change and reduce the impediments, but probably more importantly, to facilitate the deployment of capital in these rural areas.

If you think about the future, can you imagine, just to make the case quickly, there is one billion people in the world, they got [the medical 00:18:50] clinics without electricity. There are 50% of people in developing countries that go to primary schools with no electricity. For them to catch up and to move ahead in the 21st century, it's really critical that we find a way to do it. To deploy the technologies.

If you get the government work and to make it happen, I know the UN is thinking and probably in September will announce that access to electricity and sustainable development goal which I think pushes governments to start to act on this, but then the financing will come if the structure is right within the country. Probably the most important thing is to be able to scale as the capability of people to pay scales.

The big issue has always been, "Can you do this for profit?" With the [fallen 00:19:43] solar, I actually believe that solar will really make a difference, wind will make a difference. If you build a microgrid in some of these villages, it brings Doug's gen sets in to really be able to light up 24/7 a village of 500, 1,000, 2,000 people. This is a pretty exciting thing for two reasons. One, the cost of renewables are coming down, and it allows for people to have access. That transforms their lives, probably more important in the 21st century than ever.

Heather: Certainly, an important role that governments play. Governor, what policies from your perspective can be put in place to address energy poverty?

Stephen: Well, that's pretty far away from the central banking world, but I think that the primary thing I think what the others are saying is that sometimes [well-meaning 00:20:45] policies have unintended consequences, and so a more [fulsome 00:20:51] analysis of those can be very helpful. I know a Canadian company that builds LED road lighting systems.

They're able to go into a city and say, "Well, we'll replace all the lights and we'll finance it and it will pay for itself in, say, three years." After that, they say, "All the money you save on electricity is yours to keep." It's a great value proposition, but if they had just tried to sell them the lights, it would have been much harder. It's the value proposition, its totality, which matters to people.

In terms of policies here at home, it's more about reacting to the changes that we've seen. Some companies were reacting, which is quite interesting, [improving their 00:21:40] efficiencies. In the oil sector, a lot of cost-cutting that's happening, companies tell me, "Oh, we replaced our whole system of valves." Valves. It doesn't sound very exciting, and yet 10%, 12% reduction in cost for a facility.

Those kinds of things really start to add up and it's changing the whole nature of the oil supply curve. Its flexibility and how flat it is, I think. That will have a fundamental role to play in these alternative energies, but you also hear about the efficiency gains there, too. We're all better off with the stuff.

Heather: Clearly, there's a lot of new innovation and technology that is coming to bear in oil and gas sectors, as well as in the renewable sector. I was wondering if you could speak to what do you see from your vantage point at Gamesa? Are there a lot of new technology changes and opportunities for the wind sector? If so, where might those lie?

Borja: There is a lot of innovation that is going on everyday as we speak. Innovation is the key word to explain why renewables have been able to lower the cost and why we think they would keep going. In wind, for example, we are continuously looking for larger rotors to capture more efficiently wind, [neo-aerodynamics 00:23:07], lighter materials in towers, also, improvements during the operation and maintenance of the turbines to avoid downtimes. Smart ways to interact with a grid, lowering the cost of integrations in the grid.

Not only technology and innovation. I think a big part of it is business integration. How do we lower the cost of capital, how we access more efficiently financing. We have to rethink in some areas the way traditional business has been going on. I think a lot of challenges that we have in front of us can be beaten with innovation, technology and innovation, but we need to remain creative and find new ways to structure those projects.

Heather: Cost is a key driver. As you think about this from the utility sector, how much does this notion or the challenge of energy poverty factor into a utility business model?

Jim: I think as a practical point, most utilities in the US are focused on their business here in the US. Only a few do business outside the US. I know for a fact that we have an operation in Latin America. Latin America is uniquely blessed. About 50% of electricity comes from hydro. Yet, there's still 23 million people in Latin America with no access to electricity.

They're predominantly in the Amazon areas and remote areas in these countries, but I'm impressed with a couple of things in Latin America specifically. One is a focus on reaching these 23 million, but there's also a great focus on renewables. For instance, in Brazil, there's been a huge effort, particularly given the recent drought, to really focus on wind.

A great opportunity for you there, but also, last year, there was over 600 megawatts of solar deploy. Two-thirds of that was in Chile. You're starting to see,



notwithstanding the significant hydro that is there which has zero carbon emissions, they're continuing to add and really changing their mix of generation going forward.

Heather: Obviously, a lot of integration, and what happens in one country can impact the thinking in another. I was wondering, Governor, as we in the United States are dealing with a vastly changing energy picture, how does what's happening here impact your thinking and the policies in Canada, economically speaking as well?

Stephen: Well, certainly, the US [remains and 00:26:10] has always been our biggest customer, and certainly in energy. Not just in oil and gas, but we make blades for windmills and these kinds of things, so then we have a [bargaining 00:26:25] business in a lot of renewables. Solar, et cetera. We always look to the US as our number one customer that we want to serve.

Of course, that's always in a context of what the rules are or what the policies are and so on. All that matters directly to us as a business proposition. How does it affect us? It affects us in every way. It affects us exactly the same way as it affects companies in the United States. It's not actually ... We're not special in that sense.

All of that though, if you ask me, given what I've learned today, I'm actually very optimistic about this. In fact, the US economy is doing really well. In particular, the fact that the energy sector is going through a transformation with these different prices, it's probably got a lot of silver linings to it, and so, indeed, more likely to promote faster growth and slower growth. I think we all benefit from that, so I'm looking forward to it.

Heather: Mr. Oberhelman, do you agree? Do you look out and do you have a lot of optimism from an economic perspective as well?

Doug: I am very optimistic. Technology is the answer here. This is Earth Day Week. I can remember not many years ago, acid rain. Remember that one? Sulfur dioxide is killing our forest, the northeast and all up into Canada. When was the last time we talked about sulfur dioxide and acid rain? We solved that through scrubber technology, Jim, which you would know. I don't know anything about it, but I know it's there.

Jim: I spent a lot of money on that.

Doug: Yeah, but it solved the problem. That's the way through this. Technology has never [ramped 00:28:25] up. I can remember going to China not many years ago and we never see a solar panel. Today, every new building in China going up, and there are millions of them, all have solar panels on top, which has driven the cost

down, has increased the level of technology for the rest of the world, and that's helping all of us.

To me, whether it's things that we do, what Caterpillar utilities do, or whoever it is, technology is the answer. That will be part of the solution around coal because, I agree completely with Jim, the amount of coal we're going to burn in this world will drop, but the world demand for energy is going to grow as two billion people come onto our planet the next 20 years.

We are going to have to use all the sources that we possibly can, particularly in developing countries where they want to live like this. They want power and heat and the things we have. We can't cut them off from that. Coal will be a part of that solution. In fact, I think the EPA numbers are [inaudible 00:29:26] about 30% down the road in a decade or so for the US, but it's going to be all of those.

Technology is going to be a driver with the increasing rate of innovation and technology everywhere. I am really optimistic that who's ever up here 20 years from now have a lot of ... If you think about 20 years ago where they have a very different view of things, it will all be technologically advanced at that time.

Jim: Heather, if I may. Picking up on Doug's theme here, if you look around the world and you look at the technological changes that are occurring, it's remarkable. It's actually remarkable what the Chinese have done. They've lifted over 400 million people out of poverty.

Yet, today, they lead the world in solar panel production, they lead the world in wind turbine production, they're investing a lot in storage technologies, which I think is going to be transformative because I think they'll be embedded in the grid and change how we operate the grid of tomorrow. I think they're leading the way and they have 30 new nuclear plants under construction. They are really focused on the environmental implications of how they generate electricity.

I think another great example, and there's some good aspects to this and bad aspects, and that's a quick look at Germany. I really applaud what the Germans have done as they moved to more of a renewable portfolio. They've heavily subsidized renewables so that they're backing off the subsidies, appropriately so.

They've been a leader, they've been a pioneer, but I guess I'd say ... I lived in Texas for a while. We used to have a thing called the West Texas Rule. The West Texas Rule says, "Pioneers get the arrows, settlers get the land." I think we need to think like settlers. One of the lessons from Germany, one of the lessons is you don't go all in at the beginning as the cost of renewable is coming down. You feather in the solar. You feather in the wind.

If you're serious about climate, you don't shut down your nuclear plants because that's the only way we generate electricity 24/7. They've shut down the nuclear plants because the subsidies tripled the cost for residential consumers. Yet, they're now using lignite coal, which is the dirtiest coal to use, and you see their emissions rising. They will solve all this in time, but quite frankly, we in the US, with the challenge of retiring and replacing all our plants except hydro, by 2050, we should pay attention to that.

Actually, I see a huge change, a drive to change technology in the US as a consequence of having to retire and replace our nuclear as we move to the next generation, as we try to build new, more efficient gas plants, CHP, as Doug was saying. I think the opportunities are huge, but we need to look around the world and pick the best for each and all from each other.

Heather: Right, but can we ... Go ahead.

Doug: Just a quick note. We haven't talked much about hydro, but the Chinese right now are great designers and contractors of massive hydro projects around the world. South America, Africa, inside China. It's going on very quietly, but there's probably more under construction today than there have ever been.

I would argue, as some would, that that's a renewable resource, and a good one, but there's a lot of technology coming around that. Brazil has got some huge projects under way in the Amazon Basin. Controversially in every case, but it's a balance of what do we need versus how do we affect the environment.

Heather: A lot of people point to the example of the cellphone and the technology leap that it made in terms of bringing access to telephones to the underdeveloped countries. Is there a parallel here in the energy space do you think?

Jim: I think there is. There's two ways to think about the parallel. Think about if you're in Africa and 90% of the people have cellphones, and you see the emergence of mobile banking which has been ... Microloans is much [heralded 00:33:52]. Its success has been limited, but I think this mobile banking creates credit history for people.

Look at the interplay of solar, mobile banking, cellphones, storage technologies, the gen sets from Caterpillar, and then all of a sudden, you start to see how you're able to bring electricity to everybody within the country. The biggest impediment in a lot of these developing countries is really the banks.

The banks won't loan longer than five to seven years. For most investments, when you're building a microgrid, you're thinking in terms of 10 to 20 years. How do we fix that? How do we increase the equity? Actually, how do you get the

World Bank? How do you get [OPEC 00:34:41]? How do you get people more focused on not just central station plants fossil-based all the time, but shifting more the resources to renewables, especially in these remote areas?

Borja: I think that also, a trend that is helping or will help to have better access to financing is to have [smaller 00:35:04] facilities that go towards this [inaudible 00:35:08] of generation. We will not have any more in those rural areas big generating facilities of 300 megawatts. We'll more have two or three turbines with some solar panels with some storage batteries that service as much a smaller area.

That deals much better with difficulties of access to financing. That deals much better with [wake 00:35:32] grids or absent grid, and in some cases, with lack of infrastructures. We have to remember we have to transport blades that are 64 meters long to places that are remote, and we need to be able to do that in an efficient way.

Heather: How big of an issue is access to financing?

Stephen: I thought you're [inaudible 00:35:57], but anyway.

Borja: Okay.

Heather: Thank you, sir.

Stephen: Now that's a central bank question [inaudible 00:36:01].

Jim: Yeah.

Heather: Well, I don't ...

Stephen: I agree.

Jim: "Show me the money."

Heather: Epic fail.

Stephen: Well, two points on this. First of all, access to financing of the sort you're describing is actually going through a low phase right now because globally, we're all adjusting to the new liquidity and capital rules. I think that over time, that's going to go back to more normalization, but the sidebar of that is that one of the most important players in the space you're describing are the export credit agencies such as US Ex-Im Bank.

When you have an industry that's trying to go global and the financing is a big issue for these kinds of installations, well, that's what export credit agencies most often do. There's a perfect match there. It's a big gap in the market, that's what they do. They fill gaps.

Jim: Just a quick point, now power sectors are the most capital intensive industry in the world. That's clearly true in the developed world, but in the developing world, it's true in the urban areas, but actually, it's still the most capital intensive industry in the rural areas. The good news about solar, given where the prices go and how storage is emerging, is that it's proving to be the affordable option versus building a central station plant, transmission and distribution into the rural areas, and it's doable now, not 10 years or 20 years from now.

At the same time, it is the cleanest way to provide electricity in these remote areas. In the sense of the word, to pick up on your earlier question, we're leap-frogging the grid that we have in the US so we have a [inaudible 00:37:51] in moving forward, because a lot of people in developing worlds think that solar and wind are not first world ways to generate electricity. The truth of the matter is it's becoming first world. They have a chance to go without having to deal with an existing grid.

Heather: Having worked in the government myself, I know we're not always the quickest to change our thinking and react to the underground realities. How much of a challenge does this vastly changing energy picture pose for the way you think about your job on a day-to-day basis?

Stephen: Well, speaking as an economist and central banker, what we're living in right now is the most complicated situation you can design for a central banker to have to deal with. It's one thing if it's a relatively small part of your economy, but in Canada, it's a really big part. It's good for part of the economy and it's hard on another part of the economy. In the past 10 years, it's been the other way around. Rising energy crisis.

What's happened is big transformations take place in your economy, and now, you start to slow them down, and possibly, some of them will reverse to a degree. That makes strong [undercurrents in our 00:39:09] economy which are very hard to read and very hard to run policies around, so what we try to do is offer up, if you like, a cushion. The government has various programs to facilitate labor market adjustments which I hope will make it easier for the economy to adapt. The economy has to adapt more than the policies, frankly, but if we can facilitate that, that's a good day's work.

Heather: In our last remaining minutes, I think anybody who's ever thought about energy or has worked on policy, it's incredibly difficult to predict what's going to happen

with energy markets. Certainly, in 2008, we would have expected that we be building LNG export facilities because we'd had such a long conversation about how we're going to import.

I think five years ago, if you would have said the price of crude is going to be less than \$60 a barrel, a lot of people probably would have thought you're a little cuckoo. As a final question for anyone that wants to jump in, what do you think is going to be the next big transformation in the energy sector?

Jim: I'd do it quickly. I actually think storage technology will transform.

Doug: I'd vote at technology.

Jim: Actually, Thomas Edison, unfortunately, or fortunately, said in 1895 the development of storage technology will transform the power sector, and its development is just around the corner. Here we are, we're now coming around the corner, and I know at Duke we have seven [pilots 00:40:48] of different battery technologies or storage technologies. I actually think it'll be used more in the context of creating a more resilient grid than used to smooth out the supply of renewables.

I think that will be very [transformative 00:41:07]. As we reinvent the grid in the US going forward and as you look at what's happening in rural areas in the world, I think you can't underestimate the power of storage. That, to me, would be the number one technology that will transform that is not in the calculus of a lot of people's thinking.

Doug: I'll go to technology, too. Fracturing shale technology is old technology that started in the '60s, but it was the directional drill that changed all of that a decade ago. Nobody saw that coming, and something out there today is waiting for us. I suspect it's storage, but I also think it's probably big data and the ability to monitor a neighborhood, a building, maybe a city, maybe a state, and control power usage in a much more efficient way, which, today, we do not do.

I remember my dad as a kid turned the lights off at night. We don't do that very much anymore. We have cheap energy which is a good thing for us, but that allows all kinds of savings. The technology unlocked there I think is really going to be exciting. It's the answer here.

Jim: You [inaudible 00:42:24] your dad's [inaudible 00:42:25].

Doug: Yeah.

Heather: Did you have ...

Borja: Yeah. Well, I think there is going to be two main technologies that are going to be very broadly deployed. One is offgrid systems where a lot of people can cover their electricity needs without actually being locked to a grid. Second is offshore wind. Not maybe in the US, but certainly in developed countries where land is scarce still need renewable. Offshore wind, I believe, will be a technology which price will go down dramatically in the next 20 to 30 years and will be able to be a good solution for many countries.

Stephen: Well, I got two points though. I will certainly say the storage thing is one of the biggest technological leaps. I just noticed I got a new Blackberry. I only have to plug it in like every third day. That's a way better battery than what my previous Blackberry got. It's because of that basic, "We all want a better battery for our iPads," or whatever, that's what makes that technology move fast, not because some plant wants better storage.

The other thing I'll mention is garbage. Garbage is a really important source of energy. We have lots of garbage. Harnessing that I think will be ... I know there are technologies that are getting close to being really good at that. Not just the methane part, but actually disposing of the garbage so there's nothing left except energy and some distilled water. That's the kind of thing that could make a big difference.

Heather: Well, I want to thank you all for your time today. I think this has been a terrific conversation about some of the challenges and opportunities that lie ahead. Thank you.

Stephen: Thank you.

Borja: Yeah, thank you.

Doug: Thank you very much.