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Chair

Mr. Leon Benoit

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● (0900)

[*English*]

The Chair (Mr. Leon Benoit (Vegreville—Wainwright, CPC)): Good morning, everyone.

We are here today to continue our study of the status of the ecoENERGY program. Today's session, of course, is on carbon capture and sequestration.

We have two panels today. On our first panel we have, from the Pembina Institute, Ed Whittingham, director of consulting services; from the Saskatchewan Power Corporation, we have Michael J. Monea, vice-president; and from the TransAlta Corporation, we have Don Wharton, vice-president of sustainable development.

I thank all of you gentlemen for being here today. We will have presentations first of up to 10 minutes, although we would prefer them to be shorter so we have more time for questioning.

We'll start with the Pembina Institute, Ed Whittingham. You can go ahead, sir, with your presentation.

Mr. Ed Whittingham (Director, Consulting Services, Pembina Institute): Thank you, Chair Benoit.

Good morning, members of the committee. My name is Ed Whittingham, and I'm very happy to have been invited to present to you today.

The Pembina Institute is a sustainable energy think tank originally based in Alberta. We have offices nationally now. Pembina has done a fair amount of work on CCS, as have I personally, including looking at CCS options for energy companies; doing technical stakeholder and policy analysis; convening dialogues, particularly between companies, environmental groups, and landowners on CCS; as well as hosting a thought leaders forum on CCS where we brought together from around the country some of the thought leaders on the technology and how it's best applied. Those are the rough qualifications that I bring to my appearance here today.

I'd like to speak a little about the Pembina Institute's perspective on CCS, a printed copy of which you should have before you. I'll refer to it, but will not read directly from it, and put CCS in the context as one of the technologies used for fighting climate change today.

On that point, I should say right off the top that the Pembina Institute sees CCS as one of a number of technologies used. It's very useful for reducing greenhouse gas emissions and therefore useful for combatting dangerous climate change. But having said that, we see it as one technology that's part of a portfolio approach.

When we think about the deployment of CCS as a GHG solution, we also would like to see a scale-up of renewable energy and energy efficiency. We also want to see a fair distribution of CCS on the expenditure side as well. Those are two conditions for our support that I'd like to state up front.

When you think of CCS and its applicability in Canada, you have to think about it in three ways. One is, do we have the storage capability? Two, can we capture the emissions? Three, do we have the technology necessary?

On the storage side, if you look at the IPCC in its reporting, we have globally 2,000 gigatonnes of storage capacity in geological formations. If the world emits 32 gigatonnes of CO_2 a year, that would give us 60 years of storage capacity. That's not to say we're going to capture every single emission within that, of course, but it's just illustrative to say that we have lots of places around the world, and in Canada, in the western sedimentary basin, to store emissions.

On the capture side, on the supply side, so to speak, it's best applied to large point sources. Do we have those point sources in Canada? Absolutely, we have over 100 facilities that produce a half megatonne of carbon a year. Where I'm from in Alberta we have 101 facilities that produce over 100,000 tonnes of CO_2 per year. So there's ample supply.

On the technology side, can we do it? We've been injecting various gases into the ground for over 30 years now, whether acid gas or CO_2, just as pure storage or for enhanced oil recovery.

On the safety side, maybe you'll read much about it in the media, but the institute feels that really safety is not an issue, provided we adequately select our reservoirs, we have competent operators, and we have good operating protocols that carbon capture and storage can be done in a way that protects both people and the atmosphere from leaks—although, of course, we have movements; you might have heard of NIMBY, and we have BANANA, Build Absolutely Nothing Anywhere Near Anyone. In one of those cases, I think CCS is a safe technology, and proven, and by any indication.... On my flight out here I sat next to Larry, a roughneck safety specialist, and he said when dealing with different gases, CO_2 is the least of our concerns and we can handle it. So the institute is not concerned there.

If you total this up, we see CCS playing potentially a significant role in reducing greenhouse emissions and combatting climate change. Our own economic modelling shows that under varying assumptions—including assuming that there is a CCS regulation and we have the right market forces harnessed, i.e. we have the right price signal for emitters—CCS could equal upwards of a 75-megatonne-per-year reduction by 2020. That's research that Pembina itself has commissioned.

● (0905)

I won't refer to the many studies out there that show the potential of CCS, perhaps save for one, because they're presenting afterward. The Integrated CO_2 Network shows that CCS again could play a substantial role in reducing greenhouse gas emissions; in its studies, upwards of 55 megatonnes by 2020.

At any rate, if we look at Canada's overall emissions—what we hope to do, whether it's a 17% decrease or a 20% decrease by 2020—carbon capture and storage has a significant role to play. That's the good news.

I wouldn't be a representative of an environmental group if I didn't have some bad news to share. The bad news is, very simply, it's bloody expensive, any way you look at it. And as we know from the federal contribution of upwards of a billion dollars, from Alberta's contribution of upwards of $2 billion to get initial projects going, in the early stages it's going to require a significant public investment.

But the good news within that bad news story is that we can think of public investment or public support of CCS more broadly as being phased. In the first phase we're doing what we're doing. We're jump-starting CCS projects so we get three to five commercial-scale projects going. The colleague to my left here is a representative of one of those projects, and we have two others in Alberta, one that's more at the R and D stage, and potentially in northeast B.C., with Spectra in Fort Nelson, another project coming online. So we're already heading into that early adoption phase.

In the second phase, when we have wider market penetration, we can imagine other emitters, other companies and regulators, learning from those initial phases, providing the right kind of incentive, which isn't limited to a subsidy, by the way—there are other economic instruments we can use—and then companies developing plans for CCS more broadly across different point sources.

Finally, in the wide market penetration phase, we can imagine CCS being a requirement of any facility in Canada that emits above a certain threshold of carbon per year and that CCS is widely deployed.

As you can imagine, as we move across those phases, the cost of the technology will come down. In fact, there's some international consensus around the notion that if we have 20 projects internationally by 2020, that might be what we need, the critical threshold, to really bring the cost down and allow us to commercialize CCS and deploy it broadly, in the way that we need to, to reduce our greenhouse gas emissions.

Lastly, how do we pay for it?

I've talked about the one form, just direct subsidy, which we've done and which the Pembina Institute feels is appropriate in the early adopter phase.

We also, of course, need the right price signal. I'm sure I don't need to lecture this committee on the various forms of carbon pricing and what those price signals could look like. Our own modelling says that if we're to meet the federal government's own greenhouse gas target by 2020, we need a carbon price of $40 by 2011, and that price needs to rise to $100 by 2020. The national round table and other bodies have conducted similar studies. The bottom line is, for CCS to be commercialized and deployed, we need an adequate price signal using some form of carbon pricing and following a phased approach. That we would consider to be the industry emitter coin.

On the public coin, as that price comes into effect and costs come down, there's certainly a role that we can use for different economic instruments, and as I say, not limited to straight subsidies. Consider accelerated capital cost allowance for the various components of CCS as a way of incenting it. Consider other economic instruments—I'm sure you have a laundry list—things like multiple credits for CCS, loan guarantees, low interest loans, perhaps an energy consumer levy for CSS, which is being used in the United Kingdom, and a voluntary purchase of CCS offsets, CCS bonds. There are a number of things that we can use to actually properly incent it.

Mr. Chair, members of the committee, those are my comments today. I look forward to taking your questions shortly. Thank you.

● (0910)

The Chair: Thank you very much for your presentation, Mr. Whittingham.

We go now to Michael Monea from the Saskatchewan Power Corporation.

Go ahead with your presentation, please, sir.

Mr. Michael J. Monea (Vice-President, Saskatchewan Power Corporation): Thank you, Mr. Chair.

I'd like to tell you a little bit about what Saskatchewan is doing, which has importance to SaskPower on CCS—carbon capture and storage.

On the storage side and the enhanced oil recovery side, Saskatchewan has the Weyburn project, which has now stored over 17 million tonnes of CO_2 in an oil reservoir, and in incremental oil, 20,000 barrels a day. So it's a huge project that the world is learning from.

We have another project in Saskatchewan called "aquastore", which will be storing 600 to 700 tonnes a day from a refinery of CO_2 into deep saline reservoirs, which again is very important for SaskPower to monitor.

On the capture side, we have two projects, which I want to talk to you today about. One of them is the Boundary Dam 3 project, and the second is called a demonstration facility.

I'll deal with the Boundary Dam project first. We've been studying how to capture CO_2 from a coal plant for some years now. Originally, SaskPower looked at a type of capture system called "oxyfuel", which we felt was too expensive. So we went, then, to post-combustion capture, which is what I'm working on right now at SaskPower. It will be potentially the first commercial plant to capture CO_2 from a retrofit coal plant, for lignite coal, which is a very low-grade coal. Again, the world is very interested in seeing if we can manage the economics to make this work.

That plant, if it goes ahead, will be capturing one million tonnes a year of CO_2. It is designed also to sell that CO_2 to the oil and gas industry. I'm quite happy to say that I have six to eight clients right now in the oil and gas industry that are interested in buying that CO_2. So one of the questions we're answering is, what will industry pay for CO_2? We think we're getting very close to that answer, which is part of our economic package.

Boundary Dam is one of six units that we have at the Boundary Dam facility. Boundary Dam 3 is a 139-megawatt plant that's ready to be shut in, in two years. So SaskPower has taken the initiative, in conjunction with our federal government, to see if we can turn that coal plant into a viable electrical source.

What we're finding, and what we will release, is that there is a lot of life left in these coal plants. What we're also finding is that there are some tremendous efficiencies that can help drive the economics down for capturing carbon. That will be released once the project information comes out.

We have two important timelines here. One is that I'm submitting a business case to our provincial government and the board of directors of SaskPower by August this year. If it gets the go-ahead, the plant will be built by the end of 2013. Right now, we've commissioned and ordered a turbine from Hitachi in Japan, which will be the world's first turbine made specifically for a CO_2 capture unit for a coal plant. That has put us very uniquely on the world stage, because we're at the procurement stage and it's the only plant that's ready at that level.

SaskPower is very committed to this project, and the reason it's committed is that we have to find out if coal is a viable option for our utility in the future. In fact, 55% of our energy comes from coal, and we just can't have those plants shut off. We have a lot of the mining industry that supports that mine, and we have a lot of people who work in those coal plants.

We're finding that we're pleasantly surprised by some of the economics we're being shown right now. You may have heard what the cost of capturing CO_2 may be. Well, the numbers we're seeing are quite a bit lower than what the world has been forecasting. So we're very excited that, once this project goes ahead, we'll be able to actually define some of the questions that people are trying to get their heads around, such as what does it cost to capture CO_2, and is there a life for coal?

We think we can clean our coal plants up to emissions in the range of 0.1 to 0.15 tonnes per megawatt hour, which is very clean. To give you an idea, right now, we're emitting 1.2 tonnes per megawatt hour. So getting it down to that level is very important to us, which is approximately 90% capture of CO_2.

The technology we'll use at Boundary Dam 3, when it goes ahead, will be Cansolv. Cansolv Technologies was originally a Quebec-based company that is now owned by Shell Global. The construction company will be SNC-Lavalin. So they're both very anxious to make this project go ahead.

● (0915)

I'll just move on to the next plant or facility. It's in the conceptual stage right now. It's called a demonstration facility. Where this idea came up, from the provincial government, was that we saw a need to do pre-commercial testing for these capture units. There is no place in the world right now that can bring different technologies in and test at a pre-commercial stage.

For example, in one of the technologies I'm looking at right now, they're basing a lot of their engineering on a 12-inch column. Well, the absorber is 22 metres in diameter, so you have to have a much larger test bed, and that's what we are working on.

What we've done is we've gone out to industry and we've said, "What would encourage you to come to SaskPower in Saskatchewan to build your own unit to do a test, so that you could pre-commercial test your technology faster?" What they said was, "We would like to be part of three test beds that we could come in and build our unit, do our testing, but show the world that we could actually do the construction." We have, right now, Hitachi, Toshiba, Siemens, BMW, and Sojitz—other companies that are interested in testing on this concept or facility.

Where it's hung up right now is funding. We have a commitment from our provincial government. We have a commitment from industry to come in with SaskPower to build the facility. We have a $92 million request in to the federal government in order to make this a partnership between the federal-provincial government and SaskPower plus industry, and we're seeing no movement basically from the federal government to participate in this project.

I will say that if that project does not go ahead, it may actually affect Boundary Dam proceeding, because we need to have a technology platform in order to test into the future.

So we have both projects wrapped up together.

A very important date is August of this year for my first business case. The second one is, of course, for the demonstration facility. If we don't get some word that there's federal participation soon, we'll lose a window to have this facility up and running by the end of 2012, and we will have lost our international membership to participate.

Thank you very much, Mr. Chairman.

● (0920)

The Chair: Thank you very much, Mr. Monea.

We go to our final witness for this hour, from TransAlta Corporation, Don Wharton, vice-president.

Go ahead, please, sir.

Mr. Don Wharton (Vice-President, Sustainable Development, TransAlta Corporation): Thank you, Mr. Chairman.

Members of Parliament, fellow panellists, other guests, good morning.

Thank you for the opportunity to speak to you about TransAlta's efforts to develop carbon capture and storage in Canada, and how those efforts will be achieved, in large part, through the Government of Canada's ecoENERGY program.

My name is Don Wharton. I'm the vice-president for sustainable development at TransAlta.

I'll just say a word about our company. We have approximately 85 power plants, just under 10,000 megawatts of generation. That makes us roughly the same size as BC Hydro. We are Canada's largest investor-owned utility, and we have a broad portfolio of generation fuels, including coal, natural gas, small and large hydro, biomass, and wind. It may surprise you to know that TransAlta is Canada's largest investor-owned wind developer and that more than 22% of our power generation comes from renewable sources.

Today, our business strategy is focused on clean energy in two primary areas: renewables, such as wind, hydro, and biomass technologies; and clean energy technologies, particularly carbon capture and storage. With regard to CCS, our primary efforts are focused on an initiative referred to as Project Pioneer, a beneficiary of the government's ecoENERGY program. We're pleased to have Canada as a partner in this project. I'd like to describe briefly that project.

By 2015, Project Pioneer will be one of the largest fully integrated CCS systems in the world. It will be built as a retrofit to our Keephills 3 coal-fired power plant and will use chilled ammonia technology to capture and permanently store one million tonnes of greenhouse gases per year, or about a third of that plant's emissions. This will make Keephills 3 one of the cleanest coal-fired power plants in the world.

Together with the Governments of Canada and Alberta, we have formed a consortium of partners to finance, design, build, and operate this project. TransAlta's partners include Alstom, Capital Power, and a pipeline company, who together bring expertise in all elements of the project. Based on detailed engineering work this year, we expect to begin construction in 2011. Pioneer will be operational by 2015 and will run for a 10-year test period from 2015 to 2025. It may run longer. The captured CO_2 will be transported to both a sequestration site at a nearby saline aquifer and an enhanced oil recovery project in a mature oil field about 50 kilometres away. It's important that we develop each of these storage options since both will be required to handle long-term CO_2 supply from CCS projects.

Additionally, TransAlta is developing a highly aggressive knowledge transfer program to convey the knowledge we gain from Project Pioneer. As recipients of significant public funding, we have an obligation to maximize the knowledge value from this prototype project. We are developing plans with academia, institutions, industry associations, such as the ICO_2N group, which you'll hear from later this morning, and other CCS projects across the globe to leverage the learning from this effort. In turn, we expect to learn more from them.

I'd like to turn now to our perceptions of the benefits of CCS. The benefits from Project Pioneer are both environmental and economic. On the environmental front, Pioneer will remove about one million tonnes of CO_2 annually from the environment, the equivalent of taking approximately 160,000 cars off the road each year in Canada. In addition, the project will also reduce SO_2 and particulate emissions from that project.

On a broader scale, Canada's greenhouse gas emissions from coal-fired generation are about 90 million tonnes a year. Globally, coal-fired generation represents the world's single largest industrial source of carbon emissions. It is TransAlta's view that CCS is one of the very few options we have to make large reductions in these emissions within a relatively short timeframe.

There are also important socio-economic benefits that have received little attention, particularly in areas where enhanced oil recovery is possible. In assessing Project Pioneer, TransAlta conducted an independent analysis through Wright Mansell Research, which concluded that over the 10-year life of the project, Pioneer would extract at least 22 million barrels of incremental oil production through enhanced oil recovery; increase federal, provincial, and local government revenues by as much $1.2 billion from taxes and royalties; and increase Alberta's GDP by between $2 billion and $3 billion over a 14-year period. This analysis would indicate that the return on investment in Project Pioneer and the federal ecoENERGY program and other government funds is quite worthwhile.

● (0925)

Let me speak a minute about the ecoENERGY program. It has been instrumental in making this project a reality. In total, Pioneer will receive $773 million in government funding. The Canadian government is contributing $342 million to Pioneer and the Alberta government $431 million. The remaining portion will come from industry and market sources. There's no question in my mind that without this funding, Pioneer would not proceed—at least at the pace required to meet global greenhouse gas reduction objectives.

We are in the early stages and there has been a lot said about the economic viability of CCS. This issue is the single biggest challenge facing CCS today. But I must say that most of the debate about costs has been speculative, based on hypothetical numbers and little experience. I would put industry, as well as others, in that same boat.

We need to prove the costs out, good or bad, and push hard to drive down capital and operating costs through optimization, scale, and technological improvements. Only then will we really be able to tell whether CCS has a long-term future as a major tool in the fight against climate change.

In addition, the Canadian regulatory framework has not yet put a price on carbon, which will provide the ultimate benchmark for new clean technologies. If CCS, once mature, can remove large volumes of greenhouse gases at or near the price of alternative solutions, it will become a tremendous asset.

However, as with many new technologies, there's a financial gap that needs to be bridged to encourage the private sector to invest time and resources to make CCS a viable clean technology in the long haul, before there is clarity on carbon prices and technical reliability.

Thankfully, through its ecoENERGY funding for CCS projects, the Government of Canada has gone a long way to bridging this gap.

Let me speak for a moment about the need for Canadian leadership in this area.

Last month I was fortunate to represent TransAlta in a joint Canada-Alberta CCS trade mission to Europe. We met with companies and governments in Norway, the U.K, and Germany, and also in Brussels, all of whom were engaged in CCS in some fashion. While these countries have been the early leaders in developing CCS, every country that we visited said that Canada was seen as being positioned to become a world leader, if not the world leader, in this area. Why? Because we enjoy the fortunate coincidence of supportive government programs and policies, solid industrial infrastructure and expertise, great geology, and good public support.

As I conclude my remarks, let me leave with you with a few key points.

First, coal will remain part of the global energy mix for the 21st century. Coal provides more than 40% of the world's electricity and will be maintained as a viable part of the global fuel mix. It's cheap, plentiful, and is deeply embedded in the global economy. Half of the electricity in the United States comes from coal. It's not going away anytime soon.

Second, technology is the key. TransAlta believes that CCS is one of the few technologies that can deliver major greenhouse gas reductions globally in the next 10 to 15 years. More than 90% of today's emissions from coal-fired power generation can be captured by CCS.

Third, governments need to bridge the financial gap. This is not a lasting financial commitment, but an initial investment to catapult CCS technology to the point where it's a viable and a competitive solution to preserving the value of Canada's energy resources. Nothing will reduce Canada's environmental footprint or give us greater economic benefit and national security than clean coal.

Finally, there is a leadership opportunity. This can be Canada's significant contribution to the world's climate challenge in the next decade. With five major projects currently in development in Canada, our country is ahead of everyone else in achieving the G8 target of having 20 CCS projects in place around the world by 2015.

CCS is essential if Canada and the world are to address the carbon challenge, and Canadian governments have been instrumental in funding and supporting this solution.

Thank you.

● (0930)

The Chair: Thank you, Mr. Wharton.

We now go directly to questions and comments. We will start with the official opposition and Mr. Regan, for up to seven minutes.

Go ahead, please.

Hon. Geoff Regan (Halifax West, Lib.): Thank you very much, Mr. Chairman, and thank you to the witnesses for coming today.

Mr. Whittingham, let me start with you. The government appears to have invested a heck of a lot in carbon capture and storage. We've actually seen them recently kill the ecoENERGY retrofit homes program. As you note in your comments in your paper here, they've substantially underfunded energy efficiency and low-impact renewable energy production.

I'd like your comment on that and on the question of what your view is of CCS when it's used to produce more petroleum; in other words, for EOR. Will that help us in relation to greenhouse gases?

Mr. Ed Whittingham: Thank you for the question.

To your first question, looking at the role of energy efficiency and renewable energy investments, the answer is absolutely. Our belief is that in order to reduce our greenhouse gas emissions we need a portfolio approach. Of course, a group like the Pembina Institute is going to advocate for, let's say, higher expenditures in fighting climate change than we may actually receive. But we don't want investments in CCS necessarily to be at the cost of investments in renewables and energy efficiency. We think that through a variety of economic instruments and an adequate carbon price we can actually achieve all three at the same time. I want to make that point clear.

As for the carbon being used for enhanced oil recovery, it really begs a good life-cycle analysis to see what happens. If the carbon does come, do we have a net savings? The answer is in many cases yes. Certainly in the early stages, in order for CCS to be viable they need that revenue tranche. All three of us have spoken about the financial gap. When you're able to bring in a revenue source such as EOR, it helps decrease the gap. In some cases they'd use water flooding and bring that oil up regardless, so why don't we use CO_2 and save our water?

However, as I say, some studies have come out recently that indicate that the life-cycle benefits need to be better understood, and we would support that kind of analysis.

Hon. Geoff Regan: Thank you.

The 2010 budget talks about investing $1 billion in green energy over five years, including $65 million in this year, 2010-11. We're told that $850 million will be spent in support of CCS, including $120 million for the Shell Quest administration project, $318 million for TransAlta's Keephills project, and $30 million for the Alberta carbon trunk line project. Mr. Wharton said there were five, so there are two more that I haven't mentioned.

Mr. Wharton, could you tell me what the other two are that I've missed?

Mr. Don Wharton: Yes. I think my colleague from Pembina mentioned a project in B.C. by Spectra Energy, and I think you missed Saskatchewan Power and Swan Hills Synfuels. That would be a list of five: Swan Hills, Enhance, TransAlta, Shell, and SaskPower.

Hon. Geoff Regan: I'll turn to Mr. Monea now.

We've heard that government is looking at putting a price on carbon, although there's no sign of them acting at this point. But they're talking about it and looking at it. At the moment a lot of these projects are being paid for by the government—two levels of government—taxing Canadians, regardless of whether today, on Earth Day, they came to work by bicycle or in their Hummer. This is an interesting issue.

You talk about the question of what the cost of CCS is likely to be at the moment. We're now talking, it seems, mostly in the range of $150 to $200, and you, Mr. Whittingham, are saying you think it will come down and there will be a dissecting point whereby the price of carbon has to be about $50 for this to work.

Mr. Monea, do you think $50 is a realistic figure in that regard? And if that is true, what's the impact on the average homeowner in terms of electricity costs per year?

● (0935)

Mr. Michael J. Monea: First of all, Saskatchewan is getting no money from the eco-fund. We're not part of the other group.

Hon. Geoff Regan: So you get none from government—none from the provincial government either?

Mr. Michael J. Monea: We have $240 million from a previous fund that was given to Saskatchewan two to three years ago.

Hon. Geoff Regan: That is from the feds.

Mr. Michael J. Monea: That's from the federal government; that's right.

We are applying right now for this demonstration facility or supplementary moneys for the Boundary Dam, but mainly we are trying to get money for the demonstration project to go ahead.

To answer your question, the way you base the price of carbon from us as a power company is that you have an oil company that may want to buy the CO_2. The price may be anywhere from $20 to $50 or $60 a tonne, depending how far you have to pipeline, etc. The second thing, which we are guessing at and which we need a lot of help on from the federal government, is what there could be by way of a credit or whatever for the CO_2 into the future. SaskPower is guessing, but we're using between $15 and $25 a tonne. You add those two together and that's what builds your price.

But I will make it simpler. Boundary Dam 3 will not go ahead, in my books, if our cost of electricity is going to be more than, say, that of natural gas generation. If it is more expensive than that, we're not building it. That is a pretty good statement.

Hon. Geoff Regan: In other words, unless there is a price on the GHG production by natural gas, you're not viable.

Mr. Michael J. Monea: That's right. And if somebody doesn't buy that CO_2.... We're making the assumption that even our neighbours in Alberta are...they have $15 in a technology fund. Even if we use that number we can make our economics work. But you have to have a price for carbon, or else it's too expensive.

Hon. Geoff Regan: Thank you very much.

Mr. Whittingham, what are your thoughts on CCS as a response to the challenge of the oil sands?

Mr. Ed Whittingham: In our own modelling work we've shown that it would be applied in the oil sands. We have technical challenges around the purity of CO_2 streams; we don't think those challenges are insurmountable. And a tremendous amount of research and development is happening right now so that eventually CCS can be applied to the oil sands.

The Pembina Institute would support—and we have already, with Turning the Corner and its update in 2008—the CCS performance standard. Rather than a performance standard, our institute would support an outright regulation, seeing CCS as a mandated approach to new-build oil sands developments, or in fact new-build coal-fired electricity as well.

The bottom line is that we're not quite there yet to make it economic, but with a full-court press I think we can figure it out, and we should figure it out.

The Chair: Thank you, and thank you Mr. Regan.

We go now to the Bloc Québécois, to Madame Brunelle for up to seven minutes.

Go ahead.

[*Translation*]

Ms. Paule Brunelle (Trois-Rivières, BQ): Good morning, gentlemen. It is my pleasure to welcome you. First, I will speak to Mr. Whittingham.

In your report, you state that Pembina views CO_2 capture and storage as one of a number of technologies and considers it to be one of many possible solutions. In addition, the government, in its latest budget, set aside $1 billion for clean energy technologies, with $800 million earmarked for funding CO_2 capture and storage projects.

Do you feel that we are putting all our eggs into one basket?

[*English*]

Mr. Ed Whittingham: Thank you for the question.

It certainly is right now; there is a large amount going toward CCS. In clean energy I would argue that we need more than a billion dollars so that we can continue comparable investments in CCS during these early stages when these investments are needed, before the cost of doing CCS comes down, so that at the same time we have the right price signal through some sort of carbon pricing.

I will reemphasize that point: that very shortly we need carbon pricing to provide the right incentive. At the same time, were it up to me I would double the amount we've invested in clean energy and have comparable amounts go to investments in renewables and efficiency as well. That includes renewing the ecoENERGY program for renewable energy. If we lose that program, I think it will be a critical loss for Canada.

● (0940)

[*Translation*]

Ms. Paule Brunelle: You are talking about carbon pricing, but how can we set a price for carbon when the government is refusing to establish absolute reduction targets?

How could a system like that function?

Do you not think that the “polluter-pays” principle should apply and that, ultimately, people living in Quebec and the rest of Canada would end up paying for Alberta?

Finally, with an unproven solution like the CCS, we are simply applying adhesive tape to an open wound.

[*English*]

Mr. Ed Whittingham: Thank you.

To your first point, I think Canada absolutely needs a strict regulatory system to manage its greenhouse gas emissions. I think we've been close. Waiting for the United States to make up its mind could be a lengthy process, whereas I feel that we could move forward very quickly. We're pretty aware of the solutions we need, including some form of carbon pricing. Frankly, I'm agnostic whether it's through cap and trade or some form of carbon tax. We need carbon pricing and we need it soon.

As to your question of fairness across the provinces, I'll speak from my perspective in Alberta. CO_2 knows no boundaries. I agree that the polluter pays principle should apply. I think you would find that my colleagues, perhaps presenters here coming next, will agree. From what I've seen from my perspective, people all agreed that eventually the cost should be transferred to industry through the right regulatory signal, through the right carbon price, and part of that cost should also be borne by the consumer. Let's not kid ourselves. We need to pay more for our energy in a carbon-constrained universe.

What that means for Alberta and Quebec...we just want Canada to move ahead on reducing its greenhouse gas emissions through a portfolio approach.

Thank you.

[*Translation*]

Ms. Paule Brunelle: Thank you.

What I found interesting about your presentation, Mr. Wharton, is the wide range of power plants you own. In addition, most of your holdings are wind-powered facilities.

Why keep coal-fired power plants at all? Should we not be thinking instead about eliminating them altogether, given how much they pollute?

In your presentation, you stated that Pioneer is the largest integrated system, and that the quantity of CO_2 will be reduced by 1 million tonnes per year, which is one third of the total emissions. What will happen with the remaining two thirds?

[*English*]

Mr. Don Wharton: Thank you very much. That's an excellent question.

In terms of the scenario, if you like, of reducing coal from the fuel mix entirely as a solution to climate change, we actually think that strategically would not be a wise move. From a Canadian point of view, given the size of the resource that we have in Canada—a large known cost, easily accessible, low-value fuel that is excellent for power generation—coal is a wise fuel to maintain in the fuel mix. We believe that diversity of Canada's fuel mix is important. Secondly, there are places in Canada, particularly places like Alberta and Saskatchewan, where alternatives for large-scale generation are not many. There might possibly be a massive nuclear build, but not hydro as in Quebec. In fact, if we can solve the emissions problem associated with coal, then we can turn a potential liability into a massive competitive advantage for Canada. I believe this is exactly what we should be doing with CCS.

To the second part of your question around capturing one third of the emissions from our pioneer project, I wanted to emphasize that this is a prototype project. In fact, we fully intend to capture 100% of the emissions from that project, but this is a pre-commercial-scale demonstration project to prove the technology. We believe that once we do that and drive the costs down to where they need to be, we will apply carbon capture to 100% of our emissions stream, not just from one plant but from all our plants.

● (0945)

The Chair: You have 30 seconds.

[*Translation*]

Ms. Paule Brunelle: That is far too much time, Mr. Chair.

Mr. Monea, you say that your project will enable you to capture 90% of the CO_2 released. Your goal is rather ambitious, but I see that as a good thing. Where do you intend to store all that CO_2? Do you plan on storing it in geological formations or old mines? I would like to know what kind of risks that would entail. There is a lot of talk about water tables and the importance of storing CO_2 fully below the surface because of the risks involved for the surrounding populations. Could you tell me a little more about this?

[*English*]

Mr. Michael J. Monea: Thank you very much for your question.

We are taking 90% of the CO_2 from Boundary Dam 3. We will be selling it to the oil industry, which will use it for enhanced oil recovery in a reservoir.

The reservoir is very similar to those of the Weyburn projects. We have an analog or a template or a case study. That project probably has been the most studied rock per CO_2 injection in the world. What has come out of the Weyburn project, which I used to manage at one time, is that you can safely store CO_2 in an oil reservoir. The reason for this is that if you have a reservoir that can trap oil and does not leak to the surface, it's going to trap CO_2. With the core analysis, all the scientific data really validates that you can use CO_2 for EOR, but you can also store the CO_2 for thousands of years and it will not leak to the surface.

Now, the only caveat is that if there is a place where there is a problem, it is the actual oil wells that we ourselves have drilled.

I used to have an oil company. I never found much oil, so I'm very good at plugging oil wells. If you had a leak, and we could detect it in parts per million, you could just go in and fix that well. So there are remediation/mitigation processes that can make this a very safe process. And we can just go back to the Weyburn field and build on that case study. But that's where our CO_2 will be going, into similar types of reservoirs.

And then if we need it, there's one other storage, which is below. We have three separate horizons below that that are deep, deep reservoirs that can handle and hold much more CO_2. Right now we are putting other saline chemicals in from potash very safely. So Saskatchewan and Alberta have great analogs on which to base our safety.

[*Translation*]

The Chair: Thank you, Ms. Brunelle.

[*English*]

We'll go now to the New Democratic Party, to Mr. Cullen for up to seven minutes.

Go ahead, please.

Mr. Nathan Cullen (Skeena—Bulkley Valley, NDP): Thank you, Mr. Chair.

Thank you, gentlemen, for your presentation.

Mr. Monea, just to start with, do you live in Saskatchewan?

Mr. Michael J. Monea: Yes, sir.

Mr. Nathan Cullen: If you were to land back in Saskatchewan and you were to find out that, magically, Canada had a price on carbon of $30 to $40 per tonne, in terms of the projects you're working on right now, how viable would they be under this type of regime?

Mr. Michael J. Monea: They would be very viable.

Mr. Nathan Cullen: And by viable, you mean they could self-sustain, they could find the cash, they could find buyers in order to finance both the actual application and the research that's needed to keep advancing the project. Is that what you mean?

Mr. Michael J. Monea: That's correct.

Mr. Nathan Cullen: In the absence of that price on carbon, in a sense, it's an unfortunate situation—I don't want to portray this wrongly—because you have to come to government for support. You made a pitch earlier saying that without government support, this project doesn't happen.

Mr. Michael J. Monea: Correct.

Mr. Nathan Cullen: This is strange for Canadians. I assume that everybody on the panel believes in the concept of polluter pay. If you are the polluter, then you ought to pick up the tab for the pollution. Am I fair in that? I don't want to put words in your mouth.

Mr. Wharton?

Mr. Don Wharton: Indeed.

Mr. Nathan Cullen: Great. Good.

So here we have a situation where, because there's no price on carbon, the polluter isn't paying the full cost, certainly, on carbon capture. Because the government refuses to put a price on carbon, the taxpayer is then on the hook for the research and implementation of the sequestering of that pollutant.

Now, it seems to me that when government is making choices... and the government has made a choice. In its recent billion-dollar fund going out the door, 80% of it landed in this particular research field.

To you, Mr. Whittingham, would it not have been more intelligent, prudent, and acceptable to the taxpayers of Canada to have had a price on carbon rather than having to subsidize this entire scheme?

Mr. Ed Whittingham: Thank you for your question.

I think if we had a price on carbon of $40 a tonne by next year, 2011, and that were to increase, in a phased way, to $100 per tonne by 2020, our own economic modelling shows the government could reach its greenhouse gas reduction targets. And in fact if we put a higher price on carbon, and again graduate that up, we can actually meet a reduction level that would have us in line with what science tells us we need to do to reduce emissions in order to avoid dangerous climate change.

So, yes, as colleagues have said, start with 40 bucks a tonne on the low end and you're going to see it jump-start to different CCS projects.

● (0950)

Mr. Nathan Cullen: Mr. Wharton, to you, under a price regime, one would assume that the cost to your company would then be included in the price of electricity generation if there was carbon included. Is that right?

Mr. Don Wharton: That's absolutely right. We produce a public good. Any cost that we incur in terms of carbon compliance cost would be part of the cost of our product.

Mr. Nathan Cullen: As an electricity generator, Mr. Monea, this is true for you as well, that if carbon runs out on some price.... You produce electricity two different ways at SaskPower: one of them through a wind turbine, one of them through a coal-fired plant. A coal-fired plant produces so much CO_2, which either you have to pay for in a cap system, one would imagine, or you sequester it, and there's a cost in that electricity embedded in that megawatt. Is that right?

Mr. Michael J. Monea: That's correct. But we have it all. We have hydro, we have wind, we have bio. If it generates power, we probably do it.

Realistically, my point was earlier that the Boundary Dam project has to stand on its own. We cannot have a high rate increase go to our customers, so it's very important for us to have initial federal funding in order to prove and validate these new technologies. It can't be done unless the government assists us.

Mr. Nathan Cullen: Can you give us, and Canadians, a sense of the timing of when it's going to be mature? We've seen projects going from a decade or more around the world. I guess there would be some apprehension, if I were talking to the folks paying the bills for this, who are the general taxpayers, as to when we're going to see the industry go out on its own, so to speak. I assume you're going to say it's connected to the fact that there needs to be a market for carbon. Can this ever be a mature and viable industry without government support, without that CO_2 pricing?

Mr. Michael J. Monea: For SaskPower, an oil and gas company, a big component of that CO_2 pricing is what somebody will pay us for the CO_2. We have that being defined. We are making an assumption on what a potential credit may be. Now that may be dangerous, but we will have this plant up and running at the end of 2013, and we firmly believe that our government will show leadership, or the Government of Canada will show some leadership, and define what a supplementary credit or a price on carbon may be.

Mr. Nathan Cullen: About this choice question, Mr. Whittingham, you talked about the tar sands earlier. There seemed to be some technological questions about the purity of the CO_2 coming out. There's also a cost question. I'm looking at some studies that say spillage happens from time to time as well—from the Alberta government itself, from C.D. Howe. I'm looking at downstreamtoday.com, a technology group that advises petrochemical, oil, gas companies—no left-wing radical, certainly.

They're estimating the cost somewhere between $225 and $250 per metric tonne. This was an independent report commissioned by the Government of Alberta. If you equate this out to what this means, it's about $22 per barrel of oil coming out of the tar sands. From everything we've heard from oil companies working in the patch, that would be a non-viable price of production. Why so much hope for the tar sands being able to use CCS cost-effectively? Under any pricing regime, $250 per tonne is very high, is it not?

Mr. Ed Whittingham: Certainly, and I've seen a variety of price estimates, let's say on the order of $200 per tonne, or at least north of $150 per tonne. Let me first state that CCS is most financially viable on things like coal-fired electricity, and certainly we have enough coal-fired electricity to apply to—

Mr. Nathan Cullen: Just to interrupt you on that point, I'm assuming that for all these projects that we've gone out and done, these experimentations, we've chosen ideal situations in which to try them out. We didn't go into the worst situation, the most difficult carbon capture situation to try out the first round of CCS technology. I'm assuming we're locating these things in ideal geological sites, close to the source of carbon. We're not running out a thousand miles to sink it into the ground in some difficult procedure. Weyburn and places like this are good places to try this thing out.

● (0955)

Mr. Ed Whittingham: Certainly with two of the projects that received funding, like Don's project...he talked about Keephills TransAlta, Scotford Upgrader, proven technology on proven sites, where there's good storage capability. Swan Hills—in situ coal gasification capture there. I'd say it's speculative; it's more on the R and D side. And the enhanced project, the Alberta carbon trunk line, is developing infrastructure without thinking through the capture side first. I personally have some questions around that. Were I to choose to seed CCS projects, I wouldn't build in structure first; I'd build capture.

Getting back to your point about the oil sands, sure we need R and D to bring the price down. Ultimately we see it as a constraint in the oil sands; water is also a constraint, as well as regular air emissions, impacts on biodiversity. And if we can't figure out those constraints, then maybe we should think about the pace and scale of oil sands development. That is but one. At least there it's no guarantee, but there is certainly some thinking and some research going into it. Whether it's the right technology for the oil sands or something else, some other greenhouse gas abatement technology for the oil sands, I don't know, but certainly our institute says to figure that out before we go and rapidly increase development.

The Chair: Thank you, Mr. Cullen.

Now to the government side, Mr. Anderson, for up to seven minutes.

Go ahead, please.

Mr. David Anderson (Cypress Hills—Grasslands, CPC): Thank you, Mr. Chair.

I find the discussion on carbon pricing to be interesting, because we've had this discussion before, and I think we all know the reality. Maybe what isn't being mentioned here is the impact on consumers. As we've heard previously in our testimony, to bring in the carbon pricing limits that some people are asking for...I think last year one of the folks from Europe was testifying and suggested that our electrical energy costs would probably triple. Petroleum costs would at least quadruple to reach the kinds of goals we need to reach.

I find it interesting that even this morning three different sets of figures are being used in our discussion. Mr. Monea talked about $15 to $50, I think. Mr. Whittingham is talking about their numbers of $40 to $100, and even in your own document you talk about $50 to $200. I think it's good we're having the whole discussion, but the reality is there's certainly no certainty to what those right numbers are. What we do know is it will have a tremendous impact on consumers because the main effect of it will be to drive up those energy prices to make the alternatives that aren't currently competitive, competitive. I think we need to keep that in the discussion while we're having it.

I want to talk a little bit about the reference plan, Mr. Monea. You said the Saskatchewan government and industry do have their share of money committed to this.

Mr. Michael J. Monea: Yes, they do.

Mr. David Anderson: I want to ask the other two gentlemen about the concept of the demonstration plant, reference plant, demo plant. Do you think that's a good idea, a place to go and take the various technologies, try them out to see how they function, and then to go from there to the next step, which I think would be Mr. Wharton's type of project whereby you're moving to commercialization? Is this a good idea to take a look at a reference plant, a demonstration plant platform?

Mr. Ed Whittingham: Thank you for the question.

Selectively, yes, and we have demonstration projects going. I'm most excited about projects like Keephills and that we're moving forward; the project is commercial scale. That will result in large reductions of CO_2 on the order of a megatonne per year or more. Selectively demonstrate the technology on the commercial side, let's get these projects going, and then we'll truly figure out what the cost is per tonne. As you rightly say, the estimates vary. Only by running it will we be able to nail down those costs.

Mr. David Anderson: Mr. Wharton.

Mr. Don Wharton: We would also support that in a measured fashion, to do demonstrations of technologies. As I said in my presentation, we need to prove this to see if it will really work. There is an R and D component here that needs to be understood. If Canada is to play a leading role on CCS, then we need to understand the technology development pathway.

Mr. David Anderson: Do you have any suggestion then as to what percentage of money should be put into R and D at this point and what percentage of money should be put into the commercialization of it? I understand you've got a bit of a vested interest here. How important is R and D and the support for that to complement what you folks are doing? I'd be interested in answers from all three of you on that.

Mr. Don Wharton: As I mentioned, a measured amount should be in R and D. We believe the real focus needs to be on commercialization of these technologies. In the electricity sector globally, much of the technology development is done by large firms, larger than the companies that deploy them like ours and SaskPower. These are international firms—General Electric, Alstom, Hitachi—and they will carry this because they think a business case can ultimately be made for CCS technology. I don't see Canada developing a massive R and D effort around this, but it is important to test these technologies. I believe that's the concept SaskPower is proposing.

● (1000)

Mr. David Anderson: A central location you think would be.... Is that a good idea then?

Mr. Don Wharton: Yes.

Mr. David Anderson: Do either of the other two have...?

Mr. Ed Whittingham: I would agree with Don, and perhaps even less on the R and D side, in that coming back to my opening comments, injecting gas into the ground is something we've been doing for 30 years very safely. If you look at Weyburn, Sleipner, or Norway, different projects, we have a tremendous track record of safety. So if we need R and D to prove it's safe, we've done that. We really need to prove what the economics are around it. Is it viable? To do that, you need to run commercial-scale projects. So certainly we'd like to see the vast majority of funding going to commercial-scale projects and reducing significant amounts of greenhouse gas emissions.

Mr. Michael J. Monea: I'll make one comment. The reason I brought up this demonstration project is that Boundary Dam 3 evaluated three technologies, and that's pretty rare. A lot of companies pick one technology and run with it. The Basin Electric Power Cooperative, for example, did that and had to modify it because there were some issues with their first technology. We're not doing this for R and D; we're doing this to find out what the next technology will be at SaskPower.

We want to partner, and I don't want you to think that Saskatchewan is not partnering with Alberta or any other player in Canada. We are partnering up. We're doing it ourselves. We will form information consortiums so that we can all learn. If the chilled ammonia process that TransAlta is using is more effective than the post-combustion amine that I'm using, I'm going to use an Alstom system on my next plant. But if we don't pool our knowledge, we won't get the economics to where we need them to be to make this a viable option, and that's what we're really looking for in joining our forces together.

The demonstration facility is a way to look at, for example, three different technologies that can then be taken to a commercial project. So we think the demonstration facility will actually help commercialize other products faster so that other power utilities can say, "This one fits our portfolio. We'll commercialize this process." We're not doing it to keep information in SaskPower. It is exactly the opposite: we want to share this with the rest of the world.

Mr. David Anderson: Do I have a couple of minutes?

The Chair: You still have a minute, Mr. Anderson.

Mr. David Anderson: I want to come back to landowner issues. I think Mr. Whittingham mentioned them earlier. What are the landowner issues you have identified in this? In western Canada these are becoming bigger issues in a number of areas, such as pipelines and those kinds of things—and at SaskPower actually I think one of the parts of the project that has been suggested is a pipeline into the States. I'm just wondering what landowner issues you're seeing.

This typically is done into a deep reservoir that's already been used for something else, but I'd be interested in the landowner issues.

Mr. Ed Whittingham: As I said, the risks of any kind of leak, and ultimately of any kind of threat to human health from putting the CO_2 back into the atmosphere is very low. Still, as with any known conventional gas project, you need to figure out the various forms of liability. So in the unlikely event a leak occurred, there is a liability there for remediation or any kind of environmental impact. Landowners, of course, need to feel comfortable with CO_2 pipelines either crossing their ground or going into an oil and gas reservoir, a saline aquifer, beneath their ground.

I don't want to run roughshod over landowners and their rights, but from what I've seen, they're a lot more worried about sour gas and what the sour gas well next to their land is going to do than about CO_2.

The Chair: Thank you, Mr. Anderson.

We are out of time for this panel.

I thank you very much, Mr. Whittingham, Mr. Wharton, and Mr. Monea. Thank you all very much. The information you've given us on this topic is very helpful, and we're looking forward to combining it with the second panel's.

I will suspend for three minutes while we change panels. We'll be back in three minutes.

● (1005)

(Pause)

● (1005)

The Chair: We will resume the meeting with our second panel for today.

Welcome, gentlemen. I look forward to your presentations and to the questions to follow.

We have, from Capital Power Corporation, Brian Vaasjo, president and chief executive officer. Welcome. From HTC Pure Energy Incorporated, we have John Osborne, business development and strategic alliances. Welcome, Mr. Osborne. And from Integrated CO_2Networks, we have Stephen Kaufman, chairman.

We will hear the presentations in the order on the agenda, starting with Capital Power Corporation. Go ahead, please, Mr. Vaasjo.

Mr. Brian Vaasjo (President and Chief Executive Officer, Capital Power Corporation): Thank you.

Good morning to committee members and staff. I am pleased to be here with you today to provide my perspective on recent efforts by Capital Power on our front end engineering and design study related to integrated gasification combined cycle and carbon capture and storage project. Before I do that, I'd like to give you a little bit of information about Capital Power, as it is a new name in Canada.

Capital Power was launched last July through a $500 million IPO. The company was created when EPCOR Utilities of Edmonton spun off its generation business. Today our assets are approximately $5 billion. Capital Power and its affiliates develop, acquire, and operate power generation from a wide range of energy sources, including coal, natural gas, waste heat, hydro, biomass, and wind. The company has 3,500 megawatts of capacity and interests in 31 facilities across three provinces and five states. Our company was the first to reintroduce supercritical coal combustion technology to North America, and it operates the cleanest coal-fired plant in Canada.

Finally, we have been a leader in Canada's effort to commercialize near-zero emissions coal-powered technology. As we look to the future, we see that North America's population will continue to grow, and so will our economy. We also know that aging infrastructure will need to be replaced to meet the growing demand for reliable, affordable, environmentally responsible electricity across North America and worldwide. We believe the best way to meet this demand is to provide power from a mix of fuel sources, including coal.

Consider these facts. Approximately one-fifth of Canada's energy is generated from coal. Not only is coal the most abundant and cheapest energy source in Canada, with reserves that will last hundreds of years, it's also stable and a low-cost source of energy. Internationally, coal is even more prominent. The United States and China are the world's largest coal producers, with 60% and 80% respectively of their electricity generation from coal. Coal will continue to be a very significant energy source in Canada and on a worldwide basis. With new technologies and carbon capture and storage being developed by a worldwide effort, overall greenhouse gas emissions from the power generation industry will be reduced while enabling Canada's vast coal reserves to continue as a viable and efficient option for power generation for many years to come.

One of those technologies that make CCS possible in Canada and the United States is coal gasification. Coal gasification combines heat and pressure to break coal down into its chemical components, creating a synthesis gas that is mainly hydrogen. This gas is then burned cleanly in a gas turbine to create electricity. With the help of a few chemical processes, a pure stream of carbon dioxide is also produced, and this can be captured and stored in saline aquifers. This CO_2 can also be beneficially used for an enhanced oil recovery, a process by which the CO_2 is injected into oil wells. This allows more oil to be recovered and provides revenue generation opportunities.

Combining an integrated gasification combined cycle plant, or IGCC, with a carbon capture facility that would capture CO_2 results in reductions in CO_2 emissions by 85% to 90%. This is approximately one-third of what is emitted from natural gas combined cycle. Compared to supercritical coal facilities, IGCC technology has the potential to further reduce nitrogen oxide, particulate matter, and sulphur dioxide, by over 99%, and mercury by almost 70%. CCS and gasification technologies do exist. The science is sound. What we need to do is demonstrate these two technologies together on a commercial scale.

Over the past four years, a great deal of work has been done toward achieving this important goal. Following on the work of the Canadian Clean Power Coalition, Capital Power has undertaken the detailed design of a 235-megawatt IGCC facility with carbon capture and sequestration.

● (1010)

With an investment of $33 million in equal parts from Capital Power, the Government of Canada, and the Government of Alberta, the front-end engineering and design, or FEED, study will be finalized over the next few weeks. This project was specifically designed for operation at the Genesee generating station in Alberta. As this is a site-specific design, the specific details cannot be utilized on a generic basis; however, the learnings and the validation of technology can.

While we can confidently say the technology is solid and the facility could operate at the availability and efficiency levels we predicted, the business case is not there for an independent power producer in Alberta to go it alone at this time. In our environment of low power prices and capital-intensive technology, industry would need significant help from government to make the first-of-a-kind facility commercially viable in Alberta. We expect the economics of building and operating such a facility to become more attractive as recent technology breakthroughs become more widely available and as newer technologies advance. For example, we're already seeing significant strides in the development of lower-cost technologies, such as membranes for air separation. This means that a plant like this could become economically feasible without subsidy within the next 10 to 15 years.

What is important is that industry and government continue to explore options together so we can make intelligent, well-informed decisions as we move forward on a path to a smaller carbon footprint. What we have today, as a result of this study, is critical information and a major step forward for a relatively small investment over a four-year period. We can soon provide decision-makers with a true understanding of the costs of this technology and comfort that it will actually work, as we now have a benchmark against which to compare other technologies to in order to help us determine which ones make the most sense to pursue.

In conclusion, the commercialization of technology solutions, including CCS and synthetic gas technology, will ensure that we can count on a long-term source of near-zero-emission baseload power for the future. Future policies need to balance the need for investment in the critical power generation infrastructure with the requirement for targeted environmental regulations to transition Canada to a lower carbon future. In addition, because of our industry's long capital life cycles, policies must recognize the costs of investments made in generation infrastructure by ratepayers and investors. Great progress is being made towards the commercialization of these new technologies, and while much remains to be done, I'm confident we can get there through a combination of good public policy, technological investment, and industry and government working together towards the goals for our common future.

I look forward to your questions.

● (1015)

The Chair: Thank you very much, Mr. Vaasjo, for your presentation.

We will go now to Mr. Osborne from HTC Purenergy Inc.

Go ahead with your presentation, please, Mr. Osborne.

Mr. John Osborne (Business Development and Strategic Alliances, HTC Purenergy Inc.): Thank you.

My name is John Osborne. I'm filling in for Jessie Inman, who is normally based in Calgary but he is caught up in volcanic ash at the moment.

I'm going to give a very quick overview of HTC and our business, and then lead into tar sands and a proposal that we believe is the way to move forward on CO_2 capture at those sorts of operations.

HTC is a little different from our competitors in the CCS business. First of all, we are Canadian and we're based in Regina, Saskatchewan. We're in Regina because of our very important partner—our legal and commercial and technical partner, the University of Regina. We collaborate completely on all CCS matters.

We're also totally devoted to CCS. I would add another letter to the CCS, which is for "utilization". We do not actually believe that CO_2 is a waste product. Obviously there are going to be move-and-supply situations, but we believe in the long term that CO_2 can be converted into useful products.

We're not like a big engineering or oil or chemical company with a small division looking at carbon capture. We look at the whole integrated business—capturing the CO_2, transporting it, and then utilizing it either in storage or converting it to something useful—because we are in the business. I work internationally to develop these sorts of projects around the world as the business starts to develop.

I'd like to say one other thing. I notice from the previous speakers that I think only one has actually mentioned China. From our experience, China is way ahead. They're already marketing their clean coal technologies in the United States, for the simple reason that they're going to make money out of it. Then they're going to return to China, as they are right now, to start developing some very interesting carbon capture and storage and utilization projects.

I mentioned the University of Regina.

We are also different because we have a fundamental science capability. We have a full R and D centre in Regina. We have a one-tonne-a-day capture plant, where we do all of our modelling and testing and whatever.

When we have something useful, we go down to the Boundary Dam ignite coal-fired plant that SaskPower mentioned earlier on. It operates for four months, two days. We operate it by taking a slipstream of one of the units of the coal-fired plants, scrubbing it to take out the SO_2, and then we capture the CO_2. There we test not only the solvents we design, but also new processes. This is about a five-tonne-a-day unit. If it works there, we reckon it will work anywhere.

We are also working on an 11-year-old CO_2 capture plant, a commercial plant, on a coal-fired power plant in the United States. It's 200 tonnes a day. It's capturing the CO_2 from a coal-fired plant, and currently the CO_2 is being sold to Coca-Cola.

We're actually planning to scale up. This CO_2 will be linked to the new shale gas play in the Pennsylvania area, where we expect to be able to use the CO_2 to fracture the horizontal wells. That eliminates the use of water, which is a major environmental issue.

Secondly, and more importantly to us, because it's going to make money, is that we're going to be using the CO_2 and testing it for enhanced gas recovery to increase the amount of gas produced and also extend the life of the horizontal wells. We think this is a major, major event.

We're also working on a plant that is 31 years old, in southern California—Death Valley. It's 800 tonnes a day. They capture CO_2 from a coal-fired plant, but they utilize the CO_2 to create soda ash. They bubble it through their brine and go through a heating process and produce this soda ash, which they sell. We have been working on this plant for well over a year. We've completely modelled it, and we'are ready to upgrade it to hopefully as much as 1,200 tonnes a day, which would make it the world's largest commercial operating CO_2 capture plant.

● (1020)

Our process is very straightforward. If you look at any large gas plant you're going to see units there—an absorber and a stripper—that look exactly the same as in our plant. That's about where the similarities end. Inside you must have solvents that do not break down in the presence of contaminants. You also need a special design in order to reduce the operating costs. The operating costs are based on the amount of steam you need to regenerate the solvent.

I'll give you some projects we've worked on worldwide. A couple of years ago we slugged it out in Norway for the European TCM Mongstad project. This is a test site where there will be a new amine plant. We beat out all the competition, except for the local Norwegian company, which was eventually awarded the contract, which was no surprise to us.

On another example of a project we didn't get, last year we put together a $600 million project in Michigan with Detroit Edison. We made our submission to the DOE and lost out to American Electric Power and a couple of other companies. This was going to be—it's still on the books—a 2,000-tonne-a-day capture plant on a coal-fired plant, with a 70-mile pipeline and injection for EOR. The oil field is sitting on top of a massive saline aquifer, which could also be used to store the CO_2. So that didn't come through.

We did come through with the world's currently largest CO_2 capture plant. It is being designed and engineered, and will hopefully be built later this year. It is based on electric. We eyeballed this one in North Dakota many years ago. We got it a couple of years ago and then lost it for a bit. We got it back just before Christmas last year. This is a 3,000-tonne-a-day unit. We are designing and engineering it right now with our partners, Doosan Heavy Industries. As I said, this will be the world's largest CO_2 capture plant. The CO_2 will be used for EOR.

I mentioned the tar sands.We have developed a modular unit that is essentially transportable. It's pre-designed and pre-engineered. There are a couple of interesting things about this unit that will capture CO_2 from pretty well any flue gas. First of all, it's built in a shop, so you're able to bring all the pieces together in a shop in modules and test them prior to shipment to the site. Then you can erect them very quickly on site at a much-reduced capital cost. Of course, if somebody comes along and says they'd like to buy two or three of them, that will not only drop our costs but will drop the price of the units.

We feel this is a very good unit that could be used on the SAGD oilers. We would very much like to see such a unit installed in a test situation and then ramped up by adding additional units later on, as and when needed. We feel this is definitely a very good solution to some of the issues on tar sands.

Thank you very much.

● (1025)

The Chair: Thank you very much, Mr. Osborne.

We'll go finally to Mr. Kaufman from Integrated CO_2 Network.

Go ahead with your presentation please, Mr. Kaufman.

Mr. Stephen Kaufman (Chairman, Integrated CO2 Network): Thank you, Mr. Chairman and honourable members, for the opportunity to speak to your committee on behalf of the ICO_2N group.

[*Translation*]

I would like to specify that my comments and answers to your questions will be in English. The subject is complex, and I am not bilingual.

[*English*]

I'm sorry about that.

I'd like to start with a short introduction on the Integrated CO_2 Network, also known as ICO_2N. I'm the chairman of ICO_2N, and I also happen to work for Suncor Energy during my “day job”.

ICO_2N is an initiative of 17 of Canada's largest industrial companies, including the coal-fired power sector, oil sands, and others. Companies in ICO_2N represent over 100 million tonnes of annual CO_2 emissions, about 15% of Canada's total. They also represent about 95% of the current oil sands production and over 60% of Alberta's electricity production.

The group's mandate is to advance carbon capture and storage in Canada. We've been working on this goal since 2005. Over the last five years, ICO_2N has completed significant technical, economic, and policy work on all aspects of CCS, including detailed economic analysis of large-scale CCS in Canada.

Our work was instrumental in the conclusions of the Canada-Alberta task force on CCS in 2007 and the Alberta CCS Development Council work in 2008. We've openly shared all of our analysis and work with Natural Resources Canada, Environment Canada, and other federal and provincial departments. I believe it's fair to say that ICO_2N has been and continues to be the leader in CCS analysis and advice to industry, government, and the public in Canada.

I had the pleasure of speaking to this committee in 2006. Many of our early conclusions about CCS have since been verified. Today I'd like to look forward a little on how and why Canada can promote the deployment of this technology.

As to the importance of CCS, as was mentioned by earlier speakers, we have large industrial plants in Canada with the potential to capture CO_2, which are located in close proximity to world-class geological storage locations. Canada has a unique opportunity to be a world leader in implementing CCS. The potential to use CO_2 for enhanced oil recovery is a key feature in Canada, which also improves the viability and economics of CCS.

Carbon capture and storage is a critical part of an integrated energy and environmental strategy for Canada. The large volume of CO_2 reductions that are achievable through CCS makes it one of Canada's most significant ways to reduce emissions and meet greenhouse gas reduction objectives. CCS is a solution that can complement other CO_2 reduction approaches, including important ones such as energy conservation, renewable fuels, and lower carbon energy sources.

The environmental importance of CCS has clearly been identified by our colleagues at the Pembina Institute who spoke earlier. It's also been demonstrated in recent reports by the National Round Table on the Environment and the Economy and by the Delphi Group.

We've actually provided you with a couple of packages of material, along with my presentation comments. One is a report by the Delphi Group. I've included a two-page summary of that inside what we've distributed. We've also provided a copy of our ICO_2N report, which details the economic analysis and technical analysis that we've done on CCS. This is for you to review when you have time.

It is important to recognize that the Delphi report shows that CCS is both a significant volume contributor, as well as very cost-effective when compared to other CO_2 reduction alternatives.

Carbon capture and storage has been identified as an international priority as well. The G8 countries, as you know, are going to be in Canada in June. They have set an objective of having 20 CCS projects under way by 2010. The IEA has identified CCS as one of the most important technological solutions to curb greenhouse gases. The IEA stated last week that CCS presents Canada with an opportunity to develop a technology that can reduce GHG emissions on a large scale.

CCS can be the next large-scale Canadian infrastructure development that will enable sustainable growth of our energy industry. It can help to maintain Canada's economic well-being, as it allows for the reduction of GHG emissions from some of our largest and fastest-growing sectors, such as coal-fired power generation and oil sands production and upgrading. Both of these key sectors have a very real role to play in a clean energy future for North America. In addition to the energy sector, CCS could help other sectors, such as chemicals, fertilizers, steel, and cement, address their GHG intensity in the same way.

CCS is also an important part of the clean energy dialogue that is under way between Canada and the United States. An effective advancement and implementation of CCS in Canada will strengthen our position in international climate change discussions and will position Canada for larger-scale CCS deployment ahead of policy developments that may happen in the U.S. and internationally.

● (1030)

The potential for CCS has advanced favourably in the past five years. However, the significant cost of constructing CCS facilities has resulted in only a few full-scale projects proceeding globally. These are in Algeria, the Norwegian offshore, and southeast Saskatchewan, notably with the CO_2 source coming in from the U.S.A.

More extensive adoption of CCS is challenged by issues of cost, design optimization, and a lack of clear international agreement on the pace of action on climate change. Ongoing research and development is necessary to enable new and more efficient capture technologies to emerge, and to refine storage and monitoring techniques. At the same time, piloting and field demonstrations are essential to solve the cost challenge.

Accelerating deployment of CCS can set the stage for more efficient, cost-effective rapid roll-out of this technology. It can help avoid carbon lock-in at new facilities by ensuring they can be built now to have the capability to reduce their emissions in the future. It will also allow industry to learn and develop the technology, ultimately resulting in greater CO_2 emission reductions at a lower overall cost per tonne.

CCS is in a transition period. The cost of technology is wide ranging, depending on sites, and is too high to be commercial today. You'll see on page 4 of our bound report a graph indicating the cost ranges for CCS. Actually, at the back page of my presentation comments there's a graph that illustrates where we're at in CCS and the fact that we're at this transition stage.

It's important to note that this situation is comparable to that of other emerging technologies, such as renewable energy, biofuels, and new nuclear power. As was determined in the Delphi study, none of these technologies is cost competitive with their historic fossil fuel alternatives, so governments have chosen to help deploy all of these technologies by providing public support.

Governments worldwide have a role to help accelerate CCS development. Industry will contribute its part, but a joint effort from industry and government is required during the transition period. Over the last several years, the federal government has promoted the initial deployment of CCS through investments in the ecoENERGY program, a very positive and necessary first step.

The current CCS development programs in Canada are working to address the challenges. These programs have resulted in the development of more than 10 world-leading projects that span the breadth of CCS technical requirements. That's not only demonstrations, but also some of the research studies and things to do with geology in Nova Scotia and other areas of investigation of CCS. It includes, of course, lab studies, industrial scale, what we call pilots, which are of a relatively small nature, and then the large-scale demonstrations.

There are six of these large-scale demonstration projects in western Canada that are expected to be operating by 2015, and that will solidify Canada's position as a world leader in CCS. In fact, the two largest capture projects are being executed by companies that are members of ICO_2N. They are the TransAlta project that you heard about earlier, which has as its partner Capital Power, and the Shell Canada project. It's interesting to note that the Shell project is going to use an amine solvent and TransAlta's project is going to use chilled ammonia, which are two competing technologies for how this will work. These are excellent examples of using demonstration projects to prove which technology will be best. In all of these cases, of course, it's important to note that provincial governments are participating. This is a necessary element that assures alignment of interest across the nation.

In conclusion, carbon capture and storage has tremendous potential to reduce Canada's CO_2 emissions and contribute to a more sustainable energy future. Canada is on the right path with its investment in CCS and is aligned with what other countries are doing, perhaps even ahead. However, industry and government cannot rest on the current programs and projects and need to continue to invest in this work. Collectively, we require full-scale demonstration of the existing technologies to confirm costs, reliability, technology choice, and ensure public confidence.

The full range of policy options to advance major CCS capital investments must continue to be explored, both in Canada and abroad. This includes aligning the expected GHG regulations with complementary tax, policy, and specific regulations related to CCS.

● (1035)

There is a central role for government in reducing investment and regulatory uncertainty to help close the economic gap and encourage CCS. It's also incumbent on government and industry to liaise with other countries and encourage knowledge sharing to accelerate collaborative work and avoid duplication. By working together, industry and government can continue to set a positive climate for CCS and accelerate its deployment towards full-scale adoption. Given the right environment, industry will do its part by mobilizing capital and technological expertise. CCS will be a major part of Canada's energy and environmental strategy in the years ahead. Now is the time to get the policy, regulatory, and investment frameworks right and to fund ongoing work to ensure CCS reaches its full potential.

[*Translation*]

Thank you for your attention. I look forward to your questions.

[*English*]

The Chair: Thank you very much, Mr. Kaufman.

We have limited time, not enough for the normal seven minutes of questioning, so we'll go to four minutes.

On a point of order, Mr. Cullen.

Mr. Nathan Cullen: I have two quick things for the committee. First is just a request through you to the clerk's office. If we could have a list of the witnesses who are on the list of requests for the next couple of weeks, that would be helpful. There remain some confusion and consternation as to which witnesses we're getting and who is being asked.

Second, I was unable to confirm at the last committee meeting that next Thursday we're going to be talking about retrofits. I just want to confirm that through you. Has it been discussed or confirmed? Who do we have for next Thursday?

The Chair: My understanding is that next Thursday we're going to the report, unless the committee wants to continue with this. There has been some interest.

On Tuesday we have the renewable energy groups that have been asked: Canadian Wind Energy Association; Plasco Energy, which of course has the garbage project here in Ottawa as one of its things; Maritime Tidal Energy; the Canadian solar industry; and Nova Scotia Power, among others who have been invited. From Quebec one witness declined to attend, but we have another, on geothermal, which is what had been requested. That's for Tuesday.

But on Thursday my understanding is we're going to the committee report. It will be ready by then, although it's kind of putting a rush on the translators.

● (1040)

Mr. Nathan Cullen: Maybe I'll have some discussions in the interim and can come back before we end.

Thank you, Chair.

The Chair: Sure, absolutely.

Let's go to questioning. Four minutes for each party is as much as we can manage here. I'm getting some complaints from the chairs that we're not getting out of the room quickly enough, so let's try to get out a couple of minutes before 11.

Go ahead, please, Mr. Tonks.

Mr. Alan Tonks (York South—Weston, Lib.): There has been so much content, it's hard to know where to start, Mr. Chairman.

First of all, thank you.

Your last point, Mr. Kaufman.... I think Mr. Vaasjo referred to the Genesee initiative and the research surrounding that project. And we have the capture plant design feasibility projects that HTC has provided from around the world.

The point was made that the IEA, I believe, has established a target of 20 projects. Are they commercialized projects or are they research projects?

You have said there is in process an analysis of the various CCS technologies. But how are they going to be evaluated so that we're not just duplicating or replicating but are rather maximizing or optimizing the research and concentrating on the commercialization that is going to be feasible and competitive and marketable? That's my question. How is that evaluation going to take place?

Mr. Stephen Kaufman: First of all, thank you very much for the question.

With respect to the IEA, I believe the actual request went from the G8 to the Carbon Sequestration Leadership Forum to come up with some recommendations on CCS. That forum came back and said, “We believe the G8 countries should have 20 projects up and running by a point in the future, but defined and moving ahead by 2010.” So there is going to be a report back, I believe, this June on that, and there has been some calibration of which projects around the world qualify.

They are all considered to be relatively large-scale. They are not commercial. All projects around the world are being funded now by governments and industry together, because there is not a commercial profitability, but they're at so-called commercial scale. That's kind of the distinction from what may have been done previously, which is more laboratory-scale or pilot-scale.

In terms of the appraisal and assessment—and I'll defer to my panel colleagues—I think it's going to depend on individual companies right now looking at what they see from results and working through an assessment over the next five years perhaps to determine which of these technologies works best. So it's not as though there's a given international panel that's going to look at everything and decide which is the winning technology.

Brian, you may want to comment on that.

Mr. Brian Vaasjo: I would concur with those observations. What you hear around the world is that there is a significant amount of effort being put in by industry, governments, and equipment providers to look at various technologies for carbon capture and storage.

What is needed, and what they're looking for, is to have these technologies taken from the workbench and applied in meaningful ways so that you can actually achieve some carbon capture and storage and actually advance technologies.

Mr. Alan Tonks: I have a final question. What would you be looking for from government with respect to a regulatory framework that would work towards the objectives you would be looking for?

The Chair: Who is the question directed to, Mr. Tonks?

Mr. Alan Tonks: It is to whoever would be appropriate to answer or has an answer.

Mr. Brian Vaasjo: I'll be first to respond.

What industry is looking for is an environment in which government and industry are working together in a cooperative way to look at both environmental policies and environmental restrictions. Certainly costing of carbon is beneficial for the advancement of technology and for filling the gap in circumstances when that isn't sufficient. I would look for some direct funding and support from both the federal and provincial governments.

● (1045)

The Chair: Thank you.

Mr. Kaufman, we're actually out of time for Mr. Tonks' questioning. Maybe someone else will ask the question.

We'll go to Mr. Guimond for four minutes.

[*Translation*]

Mr. Claude Guimond (Rimouski-Neigette—Témiscouata—Les Basques, BQ): Thank you, Mr.Chair.

Good morning, gentlemen.

Mr. Osborne, you talked about research, and Mr. Kaufman, you talked about transition, through a green lens. I find that interesting, but at the same time, surprising. Mr. Osborne, you said that CO_2 could be transformed or converted into useful products. Could you elaborate on that? I would like to know the results of your research on useful products that could be made from CO_2.

[*English*]

Mr. John Osborne: I don't want to make a big thing out of this, but there are small uses for CO_2 right now, such as in greenhouses and to make dry ice. There are some mineralization projects beginning to take place; the CO_2 could be turned into useful minerals.

I mentioned earlier that we're involved with Shell Gas, where CO_2 could be used for enhanced gas recovery. This is new. No one has ever, in a Shell Gas play, used CO_2 to enhance gas recovery. It's been done in conventional fields.

We're also involved in deep geothermal systems, which are called enhanced geothermal systems. This is very new. It is early days. We have a potential project sitting on a hot spot in Maine. The concept is to drill deep and inject supercritical CO_2. The moment the supercritical CO_2 hits the hot rock, you get a tremendous pressure and temperature effect, which you then bring to the surface and run through your turbines to create electricity. Then you recapture your CO_2, compress it, and put it down.

The long-term area in which I think very little work has been done, which has tremendous potential, is microbial conversion of CO_2.

[*Translation*]

Mr. Claude Guimond: I have a feeling that your research is progressing. How long do you think it will take before you can market your findings or develop new products using CO_2?

[*English*]

Mr. John Osborne: It will take years. It is a step-by-step procedure. It is going to take years.

[*Translation*]

Mr. Claude Guimond: You talked about the University of Regina, about China and Norway. Where do we stand, globally, when it comes to research? In addition, do you think that the government is doing enough to support the industry or to support your research?

[*English*]

Mr. John Osborne: Globally, the Europeans are waiting on moving forward in trying to develop their projects.

China is already moving ahead. If you want to get anything done in this world, do it in China. You can do it quickly and efficiently.

I think everybody is now waiting for the United States. There are five projects in the United States—big ones—all in the $600 million range. Probably two or three of those will make it and move ahead. President Obama has a task force that I think has to come back by August of this year to recommend, I believe, between six and ten large-scale projects in the United States.

I think at the end of the day it's going to really be the United States leading, but China probably being ahead, in my opinion.

[*Translation*]

The Chair: Thank you, Mr. Guimond.

[*English*]

Mr. Cullen, for up to four minutes.

Mr. Nathan Cullen: Thank you, Chair, and I thank the witnesses.

Mr. Kaufman, you have a broad overview of the industry from your membership and your work at Suncor. Is that fair to say?

Mr. Stephen Kaufman: Yes.

● (1050)

Mr. Nathan Cullen: Are you aware of any of the money that's gone out from government so far, either provincial or federal, for CCS, and has any of that also been used in enhanced oil recovery by the project proponents?

Mr. Stephen Kaufman: I'm not certain on terms of federal funding. I know that in Alberta some specific policies have helped fund some enhanced oil recovery pilots. Just as the capture technology needs to be proven, it's not a slam dunk that every oil reservoir will work suitably for CO_2 injections. So they take one injection well and try to demonstrate over a period of months, or a year or two, that CO_2 is going to be effective. Some projects like this have been provincially supported. I can't comment on whether federal support has gone into this.

Mr. Nathan Cullen: Under the criteria right now—and I guess this is what I'm trying to get at—is it possible for an energy oil company to apply for federal-provincial dollars for CCS, and as part of their large-scale project use some of the money for enhanced oil recovery as well, as a side part? So far we've heard in all the testimony that you can use it in different ways. You can simply sequester it, or you can sequester it alongside a project that is also bringing up oil. Is that true?

Mr. Stephen Kaufman: Yes, that's certainly true. It's our view, through the work we did in ICO_2N, that enhanced oil recovery is really going to provide a financial kick-start to carbon capture and storage—

Mr. Nathan Cullen: Can you imagine that diminishing over time?

Mr. Stephen Kaufman: We do. Frankly, it'll stay flat, in our opinion. It'll grow to a certain point, but then if we're really going to be capturing 40, 60, or 100 megatonnes of CO_2 a year in Canada, we don't believe we have that volume of market for EOR use. So the EOR volume will end up being stable, but as a percentage of total CO_2 injected, it'll be reduced over time.

Mr. Nathan Cullen: I understand it on the demonstration side of things, but isn't it a strange moment in public policy whereby we're using taxpayers' money to send to energy companies to demonstrate, improve, and draw up more oil? As a free marketer, which I assume you are, it's a strange circumstance if we go to a taxpayer and say we're giving money to oil companies to sequester carbon, but as a side effect, they're also bringing up more oil for their own use and profit.

Mr. Stephen Kaufman: I guess the point is that those EOR projects would not proceed without the support that allows the carbon capture to take place. That incremental funding is needed to allow the overall project to go ahead and to allow for the beneficial aspects of CO_2 storage to take place.

Mr. Nathan Cullen: Again, to the other witnesses, how critical is a stable and significant price of carbon for the future of CCS technology?

Mr. Stephen Kaufman: I think having a stable policy around climate change is what is most important. That policy will have to encompass some element of carbon pricing, however that's chosen, whether that's through a mechanism like a carbon tax, or a mechanism like a cap and trade, or some other mechanism. Frankly, as industry, we're somewhat agnostic on that, but absolutely, having a well-understood expectation of the future of carbon constraints is going to be important to developing these projects.

Mr. Nathan Cullen: Thank you.

Thank you, Chair.

The Chair: Thank you, Mr. Cullen.

Thank you very much, gentlemen. We have this phenomenon around here that we have bells interrupt meetings from time to time, and this is one of those times. We have to go to the House.

I'd like to thank you all very much for your presentations this morning. It's been very helpful for us in our study. We've just scratched the surface, but we're looking forward to meetings on Tuesday and seeing where it goes from there.

Again, thank you all very much for coming.

The meeting is adjourned.

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