CHI-TAK YEE,P. ENG,

Title: Vice president of reservoir and production management, MEG Energy

Date and place of birth (if available): Born in China in 1961

Date and place of interview: June 22, 2011

Name of interviewer: Peter McKenzie-Brown

Name of videographer: Peter Tombrowski

Full names (spelled out) of all others present: N/A

Consent form signed: Yes

Initials of Interviewer: PMB

Last name of subject: YEE

PMB: Would you say something and I'll check my levels.

YEE: Okay, one, two, three.

PMB: That's good.

YEE: Okay.

PMB: Okay, I'm talking to Chi-Tak Yee, he's a Vice President of MEG Energy, that's M-E-G. The date is the 22nd of June, 2001.

Okay, Chi-Tak would you mind beginning just by giving me a brief summary of your life and your career and just before we began speaking, you mentioned something quite interesting about your grandfather, you might work that into your comments please.

YEE: Okay. So I was born in China in 1961 and at that time, China was under the communist regime and my father was quite into politics, apparently, I never got a chance to meet him, he died before I was born.

PMB: Your grandfather?

YEE: My grandfather, and because of the different ideologies between communism and the entrepreneurship that my grandfather had at the time, my family decided to move to Hong Kong

when I was quite young, perhaps one or two years old, I can't quite remember. So we were essentially brought up in Hong Kong. I came to Canada, to Calgary in 1979, or 1978, when I was teenager at the time, so I attended university here at U of C, Calgary and got my degrees from chemical and petroleum engineering and got out in 1985 and have been working on the oil sands, or the oil gas industry in particular, in oil sands since then, so it's about 25 years, 26 years, mostly in oil sands recovery process, dealing with in-situ recovery oil sands. I started my career with Imperial Oil back in 1985 and was there for about nine years and quite fortunate to work on the first oil sand in-situ commercial process, at the time they called the project by Esso or Imperial Oil, there for about nine years and then left Esso and re-joined with Dr. Roger Butler, we made the SAGD process. That's something I forgot to mention was when I went to U of C I studied under him who invented the SAGD process, as most of you know now. So he and I went into business together and started company called GravDrain which is essentially a consulting company providing consulting services to companies here in Canada as well as abroad.

PMB: Excuse me; let me clarify that, that's GravDrain.

YEE: GravDrain, yeah.

PMB: As in Gravity Drainage.

YEE: That's right, as in Gravity Drainage, it was a name actually made up by Roger. So we started the company and helping people to start up these...or thinking about developing these SAGD projects in Canada as well as the south side. At that time one of the most fortunate things that I was involved in with was with the Underground Test Facility Project that was essentially the birthplace of SAGD that used these dual horizontal well configurations, think of that as the MAC, I guess of SAGD development. So I was there for about seven years I guess in total and then Roger decided to retire for the third time so he asked me what I wanted to do and at that time, I decided to go on to work for Petro Canada to try to develop one of these commercial SAGD projects which was the second one, second commercial project, SAGD project in Canada or in the world for that matter and was there for about two to three years helping out in the start of the MacKay River SAGD Project. Then in 2004 I got a call from Bill McCaffrey who was the CEO of MEG Energy and that's how I came over and again, went from a very large corporation to a start up company and have been there since then working on the, again on the production aspect of the business.

PMB: So you went from Imperial's Cold Lake Project, to the UTF.

YEE: Oh well it was with GravDrain but we were actually also, at the time, one of our projects for GravDrain was to help out the UTF Project.

PMB: Okay, so with Imperial, or Esso Resources, you were working on the UTF which an AOSTRA project wasn't it?

YEE: Okay, let me step back for a second.

PMB: Please explain that to me.

YEE: Okay, sorry, I may not have explained it right. So I start my career at Esso in '85, 1985, worked there for nine years on the Cold Lake Project which was the first commercial project in recovering bitumen from oil sands formation, then left there in 1994 and then re-joined Roger Butler, at the time he also retired from the University of Calgary and both of us start up a company called GravDrain, as I said, it was Gravity Drainage, to provide consulting services to companies that engage in thermal recovery, particularly in SAGD process and UTF, or the Underground Test Facilities, happened to be one of the projects we work on at the time with GravDrain.

PMB: I understand, but the UTF was actually first developed and first tested in the late 1980's wasn't it?

YEE: That's right; UTF was a concept that was conceived by the AOSTRA, Alberta Oil Sands Technology and Research Authority. At the time there was a mandate set up by the former Premier, Peter Lougheed, to find a way to commercialize our oil sands. So that was a vehicle that was used to accomplish so AOSTRA had this concept of extracting oil sands from underground tunnels, of networks of tunnels at the time. They would build the tunnel and they were asking for people for ideas of how to do pilot data and there were two processes that were selected for that trial, one of them was the SAGD process, the other one was the HESS Drive process proposed by Chevron at the time.

PMB: Proposed by whom?

YEE: Chevron.

PMB: Oh by Chevron, okay.

YEE: So that's how the two projects started and the one that really went distance, was the SAGD process as we all know now and that was the concept of testing and using a dual horizontal well geometry with a producer at the base of the reservoir and then an injector five meters above that, so that kind of settled the whole geometry for the whole process.

PMB: And you joined MEG Energy in 2004?

YEE: That's right, but before that I went to work on Petro Canada, MacKay's Project which is right next door to the UTF Project, so at the time, Petro Canada saw that UTF was a like a leading pilot for them for their own MacKay Project, so I went over there and worked for Petro Canada for about two to three years in the MacKay, SAGD Project start up, then I joined after that, in 2004 with MEG Energy.

PMB: And you joined as a Vice President which you are today?

YEE: Correct.

PMB: And your project here was?

YEE: Our main project, we own a lot of oil sands leases, our main project at this moment is the Christina Lake Regional Project and currently has a design capacity of 25,000 barrels per day of bitumen and currently we're actually producing approximately 10% above that number.

PMB: And I thought I heard you tell me the other day that it was the first, or one of the first commercial SAGD projects?

YEE: Well it wasn't one of the first per say, but it was the first one to ramp up so rapidly from virtually no production to the main play capacity in a very, very short time.

PMB: So it went from 0 to 25,000?

YEE: Well we had a pilot going before that, was phase 1, was doing around somewhere between two, three thousand barrels per day so went from that level, from two to three thousand per day to 25,000 barrels per day, in fact its beyond that now, it's more like 27,000-28,000 now in a matter of nine months since we first steamed the wells, just to give you some perspective. When you look at all the public data available most projects won't even get to main play capacity to start with, the ones that we did go to main play capacity; it took them at least two to three years to get there. So we are quite proud of the fact that we could get up that quickly.

PMB: Okay. A couple of other questions, when did you first hear about the oil sands? Obviously, that was...no, it may not be obvious. When did you first hear about the oil sands?

YEE: Well that's kind of interesting, as I said before I was an engineering student at the U of C here, or University of Calgary here and in those days, even now, the big companies they get a lot of recruitment on campus while the students were still in school and the first, my first encounter of oil sands was actually going through one of these campus recruitment and what really struck me at the time was Syncrude Canada, just a mining company and they were recruiting for engineers and they had this glossy brochure but inside of that they attach a bag of oil sands, you know, sealed in one of those Ziploc plastic bags, I'm too sure it would pass the safety standard of today, but it was quite neat at that time that you can actually get your hands into one of these oil sands samples and poke it and you know, mess with your fingers and so on, so that was the real first time that I encountered oil sands. Now on a professional level, the first time that I really started getting interested in the oil sands was when I was doing my graduate degree, my masters degrees in engineering with Roger Butler and because of his association with heavy oil and oil sands and that was when I really started to have a professional interest in it.

PMB: Now you told a story about you, Roger Butler was in a competition to get the Petroleum...the Reservoir Engineering Chair at the University of Calgary and you went to the lecturing which he was competing for that and you told me a very interesting story about that.

YEE: Yeah, so that was the summer of 1983, Roger just retired from Esso Resources at the time in 1982 so he went to work for AOSTRA and head up the University research program at the time and then U of C, at that time, had an _____ chair supported by the government as well as the industry to look for a head for the petroleum engineering at the U of C, so they initiated this competition to look for the department head and as part of the requirement for that chair competition each candidate had to present a lecture on any subjects that they specialize in and in this case it happened that Roger Butler presented the SAGD process and I saw one of these flyers or the advertisement for Roger's lecture in that summer when I happened to work for the University at the time doing some research so I went to listen to him and that was the time that he really made a huge impression on me that he described these SAGD process, which at the time, was considered to be a radical idea, it wasn't a mainstream of process that people were thinking at the time, but as it turned out the rest of history now, it is the most dominant method of extracting bitumen from these deeply buried oil sands formations.

PMB: And you became his first graduate student?

YEE: That's right. Not only was I his first graduate student, but I'm actually more proud to say that I was the first one to graduate [laughs]!

PMB: [laughs] Okay!

YEE: So yeah, we had quite a fun time

PMB: But you remained friends for quite awhile?

YEE: Yeah, that's right. And like I say, I left in 1985 after getting MSc and then went onto work for Imperial Oil but really kept close contact for that time and then in 1994 we actually became business partners and then long-time friends.

PMB: Now I thought you told me the other day, that you have seen a document that Roger Butler wrote in 1969 in which he laid out the concept of the SAGD process.

YEE: Right, right. Yeah, he showed me in one of his parties, sitting at his house, unfortunately I couldn't get that document at this moment but it was essentially a single page document and Roger wrote on a piece of engineering paper and one interesting thing about Roger is whenever he wrote down something he also put the time to it so he could remember what time it was and I distinctly remember that piece of paper was written in 1969.

PMB: So he gave the time and date?

YEE: That's right, I can't remember the time and date but I remember the year, it was 1969 that he wrote down the concept of SAGD and it was a hand sketch that describe how a steam chamber would develop over time and the oil drain into a production well located at the bottom of the reservoir.

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PMB: But his original idea was to use vertical wells, is that correct?

YEE: Yeah, he...the idea of the SAGD came about from the solution mining potash which he was exposed to in the early part of his career and he felt that he could use the similar concept. In the solution mining is what people do is they inject fresh water, I guess, in the potash formation, dissolve the potash and then the solution becomes heavier so it drains to the bottom whereas the fresher water will remain at the top, so the concept then is that you can actually do some sort of conduit to the base of the formation, suck up the water that saturated by potash and then you can keep the cycle going, it's basically like a connection cell, so he was quite intrigued by that idea and said why can't we do that in oil sands and in this case, we inject steam which is a lighter fluid and has tendency to rise to the top and then once the bitumen is heated by the steam and becomes less viscous, then the bitumen as well as the steam condensate would then drain to the bottom of the reservoir and then get collected.

Now when he first did his calculation using vertical wells, he calculated a value to 0.3 barrels of bitumen per foot of reservoir content okay, so you think about a typical reservoir, oil sands reservoir, at the time he was working on a Cold Lake area, about a hundred feet thick so you if you let 0.3 x 100 you get about 30 barrels of production per well and even in today's standards, much higher...high standard isn't quite profitable let alone back in 1960 when virtually worth nothing, then that wouldn't fly. He sharpened his pencil many times but he still came back with the same answer in all the barrels per foot, per day. So hence he came with this idea well why don't we increase the reservoir content, so how do you do that when you're kind of limited in a vertical sense to a 100 feet and that's how we came up with this concept of when we drew horizontal wells, you know, instead of thinking about vertical, you drew it horizontally then in theory you can increase these things by several magnitude so you can get something more commercial, commercially viable and enhance the concept of marrying horizontal well and the safety process.

PMB: And the first horizontal that Imperial or Esso drilled experimentally was in 1979?

YEE: I think it was drilled in 1978.

PMB: '78?

YEE: Yeah, so sometime there about.

PMB: So they used one horizontal production well.

YEE: Right.

PMB: And several vertical injection wells.

YEE: There was only one vertical injector well, at the time, the first pilot.

PMB: Oh, okay.

YEE: The first horizontal well that was drilled by Esso, first of all, it was a ground breaking event by itself, it was a first modern horizontal well drilled anywhere in the world, it wasn't quite horizontal in today's standard, it was kind of crooked in places but that was the first time it was drilled, realistically, it had about 100 meters or so of so-called horizontal length, in today's standards that's quite short, we are now routinely push 800 perhaps as more than a thousand meters of horizontal extension. Now the interesting thing is, now if, even if you, like if you look at today's number 800 meters would be approximately 2500 feet, so if you used his rule of thumb of 0.3 barrels per foot, so you get about 750 barrels per day of bitumen and in fact this is kind of conservative in today's standard in the good reservoirs people are talking about a thousand barrels or perhaps more of production per day from a single well, and I can tell you there aren't too many wells in Canada that can do a thousand barrels a day, heavy oil or not.

PMB: Wow.

YEE: So that's the story.

PMB: That explains it very, very nicely.

YEE: Okay.

PMB: When I discussed with Vern Larson, he made the comment that, I said well why are you using cyclic steam in Cold Lake and not... and he said basically the way the geological formations are there, this was his explanation, there are a lot of hard rock stringers, shale stringers, inside the reservoir and this prevents them from building effective steam chambers, he said that's the reason this is more suitable to the Athabasca Oil Sands than to Cold Lake.

YEE: Uh-huh. Now, that's a very interesting question, because this question always get asked, SAGD was invented by Dr. Butler while he was employed by Esso, in fact, the very first patent was granted to Exxon, the mother company for Esso but for the longest time Esso has not adopted the process for the recorded operation and that question's always why and I guess one of the aspects that you mention was perhaps there are some geological difference in Cold Lake that wasn't quite amenable to the SAGD process, but having said that, if you start reading the literature today, even paper's published by Esso or the POI people, now people start rethinking about that concept, it is true that in the early part of the recovery process, a cycling type of process such as what you have in cyclic steam stimulation, they give you better performance but over time, as that cyclic nature starts to precipitate than I think then gravitates back to a gravity drainage type of mechanism, becomes the dominate mechanism and even Esso people thinking about today too, you know when these wells become more mature over time, then they actually are thinking about, well perhaps we really have to look at these gravity drainage processes a bit more and I understand Esso was actually conducting its own pilot now on the Esso lease to use the SAGD process in combination with perhaps a bit of solvent, addition to the steam.

PMB: Now we have... I've got away from my list of main questions, which is actually probably because I find this such an interesting topic, but I would like to ask you these couple of questions, if

you were to say, based on your career so far, and you're still a young man, what were your main achievements, what would you say are your main achievements or what are the highlights of your work in the oil sands?

YEE: Okay, I think the few things I'm really proud of, the first one obviously was I have the privilege and the fortunate instance to meet up with Roger Butler.

PMB: He's a man you really admire?

YEE: That's right.

PMB: Could you elaborate on that just a little bit, why, because of his intellect, because of his personal skills, because of his friendship, what?

YEE: I think it's essentially all of the above that you mentioned, but I think one more thing on top of that is that despite all the achievements he had made in his lifetime, he remained a very humble man right to the very end, he always thought that he would just happen to be guided and then this thing, he wasn't worrying about anybody else, he just happened to stumble into this process. One thing interesting about Roger, he always thought things very deeply from the physical level first and then once he got that concept figured out, he would then sit down and write the equations and try to describe that. And in order to that well, you require a deep physical thinker as well as a person who has a lot of mathematical skill that you can transfer interesting concepts into numbers and then perform the calculations and translate it into reality. He probably, was the only man that I can, that I have met in my career that was able to do that so efficiently and despite all that achievement, like I said, he remained a very humble man.

PMB: Okay and you were talking about your main achievements; we've ended up talking about Roger again.

YEE: Sure, yeah. So the other thing we did was we formed this company called GravDrain that helped to help people to get these SAGD process going and it was formed in 1994 at the time that the oil prices were rather low, especially for heavy oil prices, the whole industry was basically in tough times and one of the things that we set out at the time, was, obviously we're trying to promote the SAGD process, but I guess the other objective we tried to do at the time was to get the people who backed us in the heavy oil industry to be gainfully employed again and I think we were quite successful in doing that, it became quite a well known name in the heavy oil industry in terms of consulting services and we were able to get quite a few people working for us and not only from the monetary aspect but they actually were doing something, in my mind, useful for their career.

Then a couple other things was more to do with the association with the first SAGD process, the first demonstration of the SAGD process using the dual horizontal well geometry, the UTF and UTF, as you mentioned earlier was already started in the mid to late 1980's so at the time that I joined them, in 1994, the whole place was already functioning for quite some time so my involvement in that was more to do with the later phases in the SAGD experimentation, particularly

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the Phase B where we drill the wells about 600 meters long and space about 70 meters apart, so it's more that it's the first commercial prototype of the SAGD process and we were able to demonstrated that we can produce this bitumen reservoir at, you know, 600 barrels a day, per well, which was astonishing when you think about the bitumen wouldn't even float to start with and here we were, we can actually get 600 barrels out of it. And then later on, I was also involved drilling horizontal wells form the surface in Athabasca region and those were the first set of horizontal wells drilled from the Athabasca Oil Sands region which essentially set the precedents for the subsequent commercial developments.

PMB: Where was the UTF located, which oil sands deposit?

YEE: Yeah, so UTF is approximately 50-60 kilometre northwest of the City of Fort McMurray, so if you drive there, it would probably take you an hour.

PMB: So it is in the Athabasca deposit.

YEE: Yeah, so the main formation was looking into the rear formation where the essentially the entire Athabasca Oil Sands deposit. For example, the mining sites, this where they mine the stuff from, but its close enough to the surface. So I found that rather intriguing that we could actually drill wells from surface and be able to position them at the way that we wanted, which when you think about it, it was quite neat. And then after that, I went to work on the second SAGD commercial project, the first one was CENOVUS SAGD Project at Foster Creek. And the MacKay Project was a close second in terms of a SAGD commercial project and really got a lot of good insight of actually how you start this kind of project up and then how you get them going. Then I moved on to MacKay, as we just talked about and we were quite fortunate to be able to start a very successful SAGD project at our Christina Lake site, that we were able to produce about 10% above the main play capacity.

PMB: Great. And that's C-H-R-I-S-T-I-N-A. Christina Lake. Okay, now I would like to go back to the UTF, I have heard over the years that there is some Russian connection...

YEE: Right.

PMB: ...some Soviet connection.

YEE: Right.

PMB: And somebody told me once that he had been to Russia, or the Soviet Union to watch an early experiment that they were doing? Can you tell me anything about that?

YEE: Yeah, I think it was, like I said, the idea at the time from Peter Lougheed's government was to find ways to commercialize the oil sands deposit, particularly the ones that are buried way too deep for surface mining. As you recall the first surface mining project was started in the late 60's by Suncor so by then there was, people already had a way to figure out how to do the surface mining

stuff, but the issue with that of course, you can only address the oil sands deposit, the deposit very close to the surface, and if you look at all the oil deposit in Athabasca for example, there's only around 10%, maybe 15%, 20% of that, that can be surface mined, so we really have to find a solution for the balance of the majority. So AOSTRA at the time, they were looking for ways to, how to, promote these oil sands activities.

There were two ways you can do it, one was the joint venture with operating companies to pilot this thing, but the issue of course with that is, those activities are so much driven by the economies at the time, especially the oil prices when oil prices collapsed which happened quite often in those days, then all of activities would die down, so there wasn't quite useful way to get a sustained development model in place. So AOSTRA then came onto to the second model as well, we got to find a place that we have some control of, we could do experiments at our own pace, at our own mandate and hence, the UTF idea born and they selected a site, which is the current site, which is north of Fort McMurray. And then at the time, they were looking for ways of how to, how to extract this oil and it happened that they took a tool to Russia and saw that the Russians were using a mine type of network where they drilled wells from within the mine tunnels into the oil bearing formation and drain oil from it, so they were quite intrigued by that.

PMB: Was this a light oil or a heavy oil or a...?

YEE: I wasn't too sure, I thought it was a... it wasn't a bitumen formation, it was some oil that was removable in reservoir conditions, so they didn't require any steam and so on, but they were more intrigued by the networks of wells that you had to actually put in place to drain these oil fields. I wasn't quite directly involved, but talking to some of the people who were actually involved initially, it wasn't quite the most pleasant environment you wanted to walk into, you imagine that you got these wells of hydrocarbon flowing in, in open atmospheres, it definitely won't pass the Canadian Safety Standard.

PMB: You didn't want to light a cigarette in that environment.

YEE: That's right, you better not be a smoker when you work in that environment. So they had this concept of building tunnels and drilling wells and enhance the concept of UTF and then later on they solicited ideas, that as I talked about earlier, to ask people well what type of process do you want to try and it happened that one of the processes was the SAGD process, which I understand Roger presented in a conference held by AOSTRA in the Glenbow Museum and that's how it was conceived.

PMB: Okay, so who sponsored it? Was the main project paid for by AOSTRA or were there private companies that were also sponsoring it?

YEE: Yeah, you really taxing my memory at this moment, but I understand the AOSTRA was a corporation set up by the government initially to have that mandate, but AOSTRA always wanted to have industry participants into the project, so once after AOSTRA set up the UTF facilities they

actually went out to talk to oil companies that were active in the oil sands at the time, to join and some of them did, and so it was a consortium between the government and industry.

PMB: I worked for Gulf back in those days and I think that's when we did some of our project, like Surmont, they would pay half. We would say this is what we want to do, they would pay half and we would pay half.

YEE: In the joint venture, yeah.

PMB: They agreed, but it was our project. They simply provided the money for it.

YEE: Correct, correct.

PMB: You know they didn't try to get involved in telling us how to operate it, but they did want the knowledge that came out of it.

YEE: Yeah. So that was the first move that I mentioned earlier.

PMB: Okay, anything else that you wanted to talk about in terms of the highlights of your involvements with the oil sands.

YEE: I think I've spoken enough already [laughs]!

PMB: Any crises that really hit you? Now you mentioned, the person who wrote this article in the Oil Sands Review mentions that the National Energy Program was a crises which affected your life in a funny way, but then of course, you've already mentioned the oil price collapse of 1986, anything you want to say about either of those?

YEE: Yeah, there were two main crises that I can think of my career, the first one that you just touched on the is the National Energy Program or the NEP where the liberal government set out to regulate the oil prices in Canada and it happened at the time that I was just finishing my engineering degree at U of C here and it wasn't good timing [laughs] from an employment point of a view, so that was the first one. Second one was in 1994, that I mentioned earlier, at that time the oil prices was rather low and also the differential between the conventional oil prices and the heavy oil prices was very wide, as you appreciate heavy oil being a lower grade oil, it typically sold for a lower price than conventional oil and we call that differential, so when you actually factor in the low oil prices and the very wide differential at the time we weren't really selling oil for anything at all, in fact, there were some producers at the time had to essentially pay somebody to get the oil away, so that was the second crises, but just like an old saying in Confucius...

PMB: Sorry, there were producers that had to pay to get their oil taken away?

YEE: That's right.

PMB: In 1994?

YEE: 1994 to 1999, five years.

PMB: Wow extraordinary, I'd never heard that!

YEE: Well that was the time, for example, when the UTF Project, once you produced the oil because there was no pipeline connection...

PMB: And there was no market.

YEE: So we really had to put it into a truck to send it to somebody, because there was nowhere else to put it, so by the time you factor in the trucking costs, which is quite healthy when you have that distance, then the net back is actually negative, which means you're paying somebody to take your oil away, that was how bad it was at the time.

PMB: Okay.

YEE: So those were two main crises, but the other thing I want to emphasise, just like the old sayings in Confucius, when there's crisis, there's opportunity, and I was actually quite fortunate that I was able to benefit from those two crises, first one of course when the NEP kind of [redacted] then I stayed behind at the U of C and studied under the inventor of the SAGD process, Roger Butler, who had influence and we talked about it already, the second one, because of that happening, I left Imperial Oil and was quite fortunate after that, at the time, as we talked about earlier, Imperial Oil was so much into cyclic steam stimulation process rather than SAGD process, so at that time, after I left Esso in 1994, I was able to start to focus on the SAGD process and start working with on the UTF Project and that's really how, got me started in this SAGD industry.

PMB: Okay and you became a very successful consultant, specializing in a totally new technology, working with the guy who invented it. How good is that?

YEE: That's right; you just don't get too many chances at that, do you? [laughs]!

PMB: [laughs]!

YEE: That's why I said I was quite fortunate that I was able to take advantage of the two crises that I went through.

PMB: So the NEP essentially forced you to go on to graduate school and then the collapse of prices in the early 92's and Dr. Butler's second retirement enabled you to form a partnership with him. So these were two crises that really worked to your advantage.

YEE: Yeah.

PMB: So let's talk about, we've covered actually an awful lot of this stuff, but in your notes to me you talk about your involvement with the UTF, you've talked about that in a certain amount of detail but you said you've maintained and optimized the reservoir efficiency. Can you talk to me about how that, how you maintained and optimized the efficiency, how has...what contributions have you, as your work, made to making SAGD a much more efficient and productive process?

YEE: So if you think back, not too long ago, 10 or 15 years ago, oil sands was a very marginal business, prices were relatively low and very high differential between conventional and light oil and people talking about, you know we're running out of conventional oil and we need to do something about it and the business model at the time was to spend some dollars to buy some land and perhaps drill a few wells, figure out what's in the reservoir and then hopefully you can flip that to somebody else who had a different pocket and make a profit out of it, but that doesn't really do anything from a production point of view you know, and then obviously with time, then people say well we need to start thinking of how to produce these things and that's how the UTF Project and the SAGD process came along and so on and when some of these projects started to come up, then people realize that, you know, having the oil in the ground obviously is important but the reservoir quality is equally important. You know the fact that we got this oil in the ground, doesn't mean that it comes to the surface by itself and that's when we start thinking about well, if reservoir quality is important then we're going to spend allot more effort figuring out what is in the reservoir.

So my from my point of view, what I do in MEG and other companies before MEG was really start to understand this reservoir better, as much as I can and try to figure out it whether they're commercially viable before we put the capital, this is a very large capital investments, before we build these projects, so I spend a lot of time in doing it and that's the second aspect. The third aspect is once it comes on production, how do we actually get this oil at a commercially viable rate and also do it efficiently, and if you look at the projects out there today, the good project will take about, anywhere from two to three barrels of steam injected to get a barrel of bitumen out, the number 2.5 seems to be the gold standard of what we call Steam/Oil Ratio, that tells you how much steam that you need and this is the oil that you would use and I spend a lot of time with my team here, everyday, to try to figure out how do we actually, (a) to get as high rate as possible for the well, and (b) how do we improve the thermal efficiency of these processes, namely reducing the amount of barrels of steam that we need for every barrel of bitumen that we get. The other thing we have to also be mindful about that is the elementary issues we're facing everyday and the fact that we can reduce the amount of energy, in terms of steam, we inject into the ground to get this oil will be that much better off for the environment as well.

PMB: And the reason that the low steam oil ratio is important is that, there are two things: 1) that you use less energy, therefore costs are lower...

YEE: Costs less.

PMB: ...and, you mentioned an environmental aspect?

YEE: Because it would reduce the amount of emissions that you would generate.

PMB: So the CO_2 emissions.

YEE: CO_2 and it would also reduce the amount of water requirement, because the fact that you need less barrel steam, that means you require less water.

PMB: Now the one thing that has developed, I believe over the last ten years, is that you don't use surface water or even ground water, you use brackish water from subterranean reservoirs, subsurface reservoirs, is that correct?

YEE: Yeah, if you look at most of the in-situ projects, first of all, we don't use any surface water as you mentioned, most of our water sources come from underground non-portable water that's not suitable for consumption and we use that to assist our steam generation, now even with that, we still recycle a large portion of it, something in the neighbourhood of 90%, so even this water is not suitable for consumption, we still recycle that, to minimize the usage of that but it's actually a win-win-situation because when they produce from these reservoirs we obviously go the oil coming back but you also get the condensed steam in the form of hot water and it carries a lot of energy in it, because its hot, so we actually do a lot of heat, what we call heat integration on the surface to use the cooler water that's coming, heat exchange with these much hotter waters and extract as much heat back as possible from it, so it is really a win-win-situation in that sense.

PMB: Okay now, so this leads me to a... I think a very topical question, what... there's a lot of discussion about the environmental benefits of in-situ production versus for example, mining or other forms, how would you describe the main environmental benefits of using in-situ and especially SAGD, compared to other forms of oil and gas development and you don't have to limit your answer things that are common in Alberta or Western Canada.

YEE: Yeah, so the first development in oil sands was the mining process that we all know and is seems to be the focus of the media at this moment is to see how much ground disturbance that is associated with mining or surface mining industry, as I mentioned earlier, the in-situ which is really the bulk of oil sands they way too deep for mining in any case, so we really have to find a way to officially extract that, so if you look at what a typical in-situ process looks like, SAGD or cyclic steam stimulation, the very first thing that really would strike a lot of people is that the surface disturbance is very, very much needs renewed, and the way that we do that is to, obviously you need to build a central plant, which they're small, then you have these wells that are located away from the central plant, to feed the production back to the central plant and if you look at the surface footprints of that, these plants are very, very small, they are about 5-10% of the surface that is used relative to the underground drainage.

So for example, if you think about a typical horizontal well, that 800 meters long, they are about 100 meters wide from the next door neighbour, if you work it out, they are equivalent to about 16 football fields, in area for a single well pair, so if you think about it we always talk to the Americans when we're raising capital from them, if we can relate to an NFL game, so you have what 32 teams

in the NFL, so you've got 16 football fields for one well pair coverage, so theoretically you can actually have the entire NFL teams to play in a single well pair area that it occupies, okay, now we'll stop at that, because when we drill from a pair, we have multiple well pairs, and the typical number will be about six well pairs for example, so six well pairs, so six well pairs would be almost 100 football fields, to give you some sense of scale, if you put the map of downtown Calgary on the map and you figured out how big an area those six well pair we drain, it's about half to ¾ of the size of downtown Calgary, that's the underground areas that you access, but on surface there's only about 5%-10% of that that is actually visible to anybody, again this is another win-win-situation, the fact that we can reduce the amount of surface footprints also reduce the number of pipelines that need to connect that to the central plant, in fact that was the very first motivation of doing pat drilling is to really concentrate all your drilling activities in one single area and also the subsequent infrastructure that needs to serve that and by doing that efficiently than you really have a reduction in the cost of capital in doing that and on top of that, the disturbance is reduced to a much a lower value, 5 or 10% of that.

PMB: One question on that, in surface mining, for example, Syncrude, Suncor, they are able to recover 97% of the oil in place, what are you able to recover through SAGD?

YEE: If you look at the more mature SAGD projects out there now for example, there's CENOVUS Project at Foster Creek and they are talking about recovery in some of the most advanced pair, somewhere in the neighbourhood of about 70%, 7-0.

PMB: 70%?

YEE: 70%, yeah, in some of advanced pairs.

PMB: Holy mackerel!

YEE: And people haven't really stopped there yet and one of the interesting things about the SAGD processes, once they heat up the reservoir and these well pairs, we actually have been in operation for a long, long time, in fact, I have yet to hear of intentional abandonment of a SAGD well pair and the one the one that I worked in on the UTF they actually last for 14 years or almost? And the only reason why they abandoned those was because they were drilled from a mine and it was way too expensive to maintain but the ones that were drilled from surface, I have yet to hear of one being abandoned. The interesting thing about that is when you heat an area or avoid them for so long there's a lot of heat retained in the reservoir, to give you some sense of the heat distribution, for every unit of energy we inject into the reservoir, we only produce about a third of it back in forms of hot fluids, the other two-third of the heat or the energy stay in the ground so people are looking at ways now, it's now that you heat up this reservoir for long enough time, leaving it still warm and so on and people actually start thinking about, you know, perhaps we should drill new wells into it to look for these bypass oils, very much in the conventional oil business, when you do a water flood, you tend to infill that after awhile to look for that bypass oil to increase the recovery and this is exactly what is being done with the SAGD process, so it doesn't surprise me that we are talking

about normally about 60% recovery, but as I said, some of them have gone to 70% but it won't be farfetched to think that we would probably go into the 70% plus range over time.

PMB: That's extraordinary. Okay you were talking about some of the environmental benefits and that would certainly be one of them, less ground disturbance...

YEE: Less water usage.

PMB: ...less water usage, less habitat destruction.

YEE: Correct.

PMB: What else would you add?

YEE: The other thing is we're also doing, in our project at least is, we also combine the electricity generation with steam generation, what we call co-generation, the idea is, in the power generation business, you can see this is the reason why a lot of power plants located right by a water source, because they need a cooling source for the heat that generates the power plant, so then you think about the SAGD project is really a good heat sync, it was a power plant it will be a heat source, so we now process, we actually have a co-generation unit, that we use natural gas to generate power and as you realize, a lot of Alberta power still today, very much based on coal fires, about 50%-60% of that is basically a coal fire and that emission is largely because of the carbon intensity so what we're doing now is that we take the natural gas molecule that would otherwise be used for steam generation SAGD, we actually use it first to generate power and then the hot exhaust gas from the natural gas power generation that would then be fed to a heat exchange, or what we call a heat recovery unit to generate steam, so the combine of that will give you more efficient process than a stand-alone power plant and a stand-alone SAGD plant.

PMB: Are you able to basically sell that power to the grid?

YEE: That's correct.

PMB: So it actually offsets your expenses a little bit.

YEE: But not expenses, but also it offsets a lot of otherwise carbon based coal fire generation.

PMB: Very interesting, is there anything else you would like to add to that? You've given us quite a good list so far.

YEE: And I guess the other thing that people should... let me just cover a bit on the recovery level that you mentioned earlier, we talk about mining, we talked about SAGD but I want to put into perspective how would that compare to conventional oil extraction, if you look at the lighter oil, which is something that is as fluid as water, the recovery factor for that type of oil, it depends who you talk to, but the recovery range is somewhere between you know, 15%-25%, so there's a huge

amount of oil left in the commercial reservoir, I found that rather amazing that in a reservoir that the stuff is so viscous, it's almost like solid in its initial stage, we can actually get through that such a high recovery.

PMB: In most conventional reservoirs, the recovery rate is only 15%-20% is that what you're saying?

YEE: Yeah, that's right, that's right.

PMB: And whereas in the SAGD you're recovering up to 70% and even more.

YEE: Yeah, yeah, I think someday we'll get there but we're still talking about 60% plus, but I think over time we, it doesn't surprise me if we go higher.

PMB: What do you see of the role of Alberta's Oil Sands in terms of the world energy, or the word "World Crude Future", let's say of the next 30 years?

YEE: Well if you take a look at the production and the consumption profile of the world, we, the next oil has to come from these unconventional oil areas, particularly the oil sands, so if you look at all of the producers today, the ones that really have the spare capacity is obviously southeast, they still have some capacity but most of the open countries are running out in terms of this capacity and the one that really can be brought on is in Canada and perhaps in Russian and Venezuela as well, so these barrels are going to be very important going forward in my view.

PMB: There's also an argument that for 30 or 40 years globally, there's been a "blackening of the barrel" do you know that expression?

YEE: Yeah, heavy...

PMB: So that it used to be that oil was very light and a very high quality that was available very cheaply and now the oil that's available is not as high quality and it's a lot more expensive.

YEE: Correct, correct. And we started seeing a trend of that and the other thing we mentioned, is the API of the oil is certainly has a tendency to come down from what it used to be.

PMB: Anything else that you want to comment on that?

YEE: I think this is the area that we should really talk about as a Canadian because as I mentioned earlier, that we have, if you look at some of the studies done, I think there was one done in 2003, bitumen started being recognized as proof reserve for the world and the number that I seem to remember is somewhere to 175 to 200 billion barrels or somewhere in that neighbourhood and that would effectively in second place in terms of oil reserves, just behind Saudi Arabia and that would provide, if you do a quick calculation, heavy oil maybe worth $50/barrel so you got $50 x $200 billion dollars and you're talking about $10 trillion dollars and that's just on the oil itself and think of all the spin-off activities, somebody's got to upgrade this oil, somebody's got to provide surface to

this industry, the economic benefit is just staggering when you think about it and if you also look at the benefit of that, it's not just to Alberta, but also to Canada as a whole, like we order a lot of the equipment outside of Alberta, we have a lot of not just equipment, but labour, you know we hire people, I don't know if you've heard that or not but we actually have people flying in from Victoria or Vancouver Island.

PMB: From Nova Scotia.

YEE: Vancouver Island routinely come in from west coast, from the east coast, we've got people as far as Nova Scotia or Newfoundland to fly in and work on these projects, you know, I can't think of another country that actually has that kind of resource and dominance, you know, just, I could be ashamed that we don't put our national effort in effectively exporting this oil, obviously we need to do this thing in a responsible way, but at least we have the oil to start with, a lot of countries don't.

PMB: Eric Newell talks about the development of the oil sands as being a "nation building project like the building of the railroad in the 19th century", any thoughts about that?

YEE: Well, no... I can concur with that, it's a tremendous effort that requires a scale to the national level to get there.

PMB: I think right from the beginning from 100 years ago, 120 years ago, when the first wells were drilled into the oil sands, those were drilled by the federal government if I'm not mistaken and then later on the Alberta Research Council started developing and experimenting and toying and of course Karl Clarke played an important role in that, I think I would like you to, like to ask you to comment on the role of government in this project development, you can see that there's certain kinds of write offs at tax time from income tax, there are certain incentives like those that were provided by AOSTRA, research provided by Karl Clarke and others, if this is a building project like that of the railroad in the 19th century, what are the roles of industry and what are the roles of government?

YEE: Well you know I'm personally not a fan of government intervention, but having said that...

PMB: This goes back to your grandfather in China [laughs]!

YEE: ...that's right [laughs], but having said that I really have to say that the Alberta Government particularly during the era of Peter Lougheed has really done the right thing for the Province, the reason I said that is because the oil industry, particularly in the heavy oil industry, it's so volatile, I don't think you can rely on the public industry to show their entire effort in doing that because at the end of the day, they have to answer to their shareholders. This is a much longer term ambition that requires a much broader mandate from a government type of organization so they can see these through and we have done exactly that in my view, the set up of AOSTRA has really changed the way that research was done at that time, remember, we talked about earlier, the one model was the government essentially give tax money to joint venture with the operating company but then you're at the mercy of the companies at the time or the operating performance of the company at the time,

and the second model, which I thought was a more useful model, is to actually get the governments to get into it and start the process of doing the research and in this case, it happened that the SAGD was the end result of that and I also, like to, am quite happy to see that. Once after that was done, the government started back out from the business you see, and once we got this developed, it returned back to the private hands and they said, well you guys can charge on with that.

PMB: So your view then is that government has played its role, just as in the railroads, at some point, government got out of the business.

YEE: Yeah, the government got into it at a tough going and essentially got the framework working, in this case, deriving what I call an "enabling" technology, SAGD, so once that technology is in place and the people can see that yes, it's a profitable venture then the rest of the public industry started go.

PMB: Well that covers most of the questions that I had, oh, I do want to ask you, you've mentioned Roger Butler a lot and he obviously was a towering figure, Vern Larson told me that his lifetime achievement was to make 250 billion barrels of oil available to the world.

YEE: Become economic.

PMB: Economically available...

YEE: Yeah.

PMB: ...which is extraordinary, are there any other really important people that you have mentioned, or that you have met and worked with in your career that you think need to be mentioned here?

YEE: Well there were four people that I can think of at this moment and three of them I had the privilege to encounter at one time or another in my career, the first one that I did meet was, of course, Dr. Clarke that you mentioned earlier, his hot water separation process essentially set the foundation to the mining industry which is still being practiced today, so that was the first one that came to mind. Second one is Roger that we already talked about in length, his invention of SAGD is just tremendous, the third one that I really want to acknowledge is the former Premier, Peter Lougheed, he happens to sit on our board of directors as well, and his vision of commercializing oil sands was decades ahead of anyone else, he was really ahead of his time in terms of thinking.

PMB: A detail on that, I understand that the AOSTRA, that AOSTRA was the biggest research project in North America, except for NASA.

YEE: Oh is that right?

PMB: In that period.

YEE: Oh I didn't know that!

PMB: Only NASA was much bigger, but it was the biggest research project in North America at that time.

YEE: Okay, well there you are.

PMB: So Peter Lougheed, whom you mentioned he was a very important figure and I hope to have a second interview with him soon.

YEE: Okay, good, good. And then the last one here is our CEO, Bill McCaffrey here, I'm talking about him to try to get some brownie points, but you know when you think about the oil sands industry, you know, 10 or 15 years ago, people always thought that it was big boy game, what I meant by that is the capital, the cost of building these projects just immense, huge. So that's the first thing and the second thing, you really need to have a deep technological knowledge or know-how in building these things and then you need a large structure to execute it, so that's why it would belonged in the big boys hands. I was quite amazed that Bill, by himself, entrepreneur by himself, was able to assemble the land base that he put together and be able to raise money and then build a team together that we have successfully transformed this company from a start-up company, essentially from his basement, to a ten billion dollar property trader company today.

PMB: So what was Bill's focus, I used to know him, I used to work at Amoco when he was there. So was his focus after he left Amoco entirely on developing oil sands?

YEE: Yes, I understand he left Amoco in the late 1990's.

PMB: It was around 1997, or something like that, just before it was taken over by BP I believe.

YEE: That's right, so he spent a lot of time thinking about how to develop some of these projects because obviously, as you know, his background in Amoco was primrose heavy oil projects, it wasn't a strange thing to think about that he would get his hands again in heavy oil. And then he was able to compete effectively with the big boys, in fact in my mind he'd beat multi-companies in the process of doing that.

PMB: So was MEG the first oil company to have the idea that it was possible to develop the oil sands even though you're a small player?

YEE: It wasn't the first company, I think the first company would've been Deer Creek, I think, but it was the first company that can, as I said...one of things I said earlier was, those days people were thinking about identifying the barrels in the ground and then effectively sell to somebody else for profit, but Bill's mind was never in it, his mind was find the oil and then produce it. He had no intention of flipping it, he really wanted to be a builder that build something and get the oil from out of the ground. I think we're the first company that has done effectively, to the conceptualization stage, identifying the resources in the ground to a bone fide, ENP Company.

PMB: That is a very interesting concept, he was recommended for this project and so I will discuss with my colleagues the idea of adding him on.

YEE: Okay.

PMB: Is there anything else that you want to say? We've had an awfully interesting discussion, I think an awfully interesting discussion.

YEE: I think I've covered most of it. I guess one of the things you that mentioned earlier, the AOSTRA budget. AOSTRA was one of the largest, or second largest research project or budget at the time. The other thing that I think we should also think about too, Americans also have their share or similar share of bitumen, it's what you call the oil share, but before the technological might of the Americans, they never really make something out of their own shale yet and here we are as Canadians one-eighth or one-ninth of America who are able to become a leader, undisputed leader in mind, in heavy oil technology.

PMB: Now is that because of the production characteristics of the oil sands compared to the oil shales?

YEE: Well there was definitely some difference in it, but in terms of the harsh reservoir environment you have to face, they are very similar, we both dealing with an oil that won't flow at all, in its naked stage and they're also buried relatively deep but yet we somehow found ways to do it. And if you also look at Venezuela as another example, Venezuela's another big heavy oil deposit, in fact, I think they probably have a better reservoir than we have because their reservoir is buried deeper in the ground and hotter and the oil is able to flow at the native stage, but yet, if you think about heavy oil technical leaders or technical business leaders, you automatically think of Canadians and to me that's quite remarkable.

PMB: How would you explain that? Is it because of AOSTRA to a large extent? Is it because you have this enormous resource in a fairly small area? Is it because of the way the oil property...the ownership by the Province of the resource?

YEE: I think it's a combination of factors, first of all, I think that obviously we've got to have the oil first and also a ownership structure that encourage the production of this right, you can lease from the Crown, so there's access to the land. On top of that, I think we are pretty innovative type of people, you know, we're fortunate to have guys like that we talked about earlier and another thing that I didn't mention earlier, was you need horizontal well to make the SAGD process commercially viable and after we drew that first well in Cold Lake and Esso, the horizontal technology started to advance quite rapidly and we were transporting that technology, not just for bitumen type of reservoir but we started using it in heavy oil and lighter oil and that technology itself, again Canadians also stand at the forefront of that. So that demonstrates, that gives you a demonstration that you know, somehow we found ways to do these things.

PMB: That's interesting. Vern Larson tells me that Esso got the idea of cyclic steam stimulation which they use at Cold Lake from Venezuela. It had already been used there.

YEE: Right, yeah, it was invented by Shell at the time.

PMB: That's right. And he also told me, by the way, that Esso in the earlier 70's had drilled a horizontal well at Norman Wells...

YEE: Correct.

PMB: ...at the Norman Wells light oil field.

YEE: Correct.

PMB: So that had happened actually before the one that was drilled for SAGD.

YEE: Okay.

PMB: Because something that you said the other day interested me in that.

YEE: Okay.

PMB: Okay, that covers most of the things that I want, you mentioned Bill McCaffrey as a possible person to interview for this project, is there anyone else that you can think of that would be really important?

YEE: I think it would be nice to interview somebody from AOSTRA for example, I can't think of a name at this moment.

PMB: I'm talking to Eddy Isaacs in a couple of weeks.

YEE: Right okay, maybe you can ask Eddy for... I was thinking about more the original people that you know way back in the 60's or 70's, I'm not too sure Eddy was there at the time, Cam Bowman seems to be a name that comes to mind.

PMB: Ken?

YEE: Clem Bowman, I think that's his name.

PMB: Oh, yeah, we are interviewing him, Bowman. I'd forgotten his first name.

YEE: No he certainly would be a...

PMB: Yeah, he was a major player.

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YEE: Yeah, he would give you a very good perspective of how they were set up and so on, and the reason I mentioned it is Roger seemed to mention his name quite often in our conversation, I never had a chance to meet him but that's what I heard from him.

PMB: I'm going to turn this recorder off now.

END OF RECORDING.