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Transcript

THE NEW AGE OF OIL: CLIMATE IMPACT AND POLICY RESPONSES

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JAN TECHAU: Good morning, everybody. Welcome to Carnegie Europe on this Monday after Easter. It's great to have you all here. My name is Jan Techau and I'm the director of Carnegie Europe and it's great to see that we have such a great, very distinguished crowd to talk about energy this morning. As you know, Carnegie Europe has set itself the task to stimulate the strategic debate in Europe and over the last few years what we have seen certainly is a geopolitical earthquake or tectonic shift.

Part of that tectonic shift that also affects Europe has to do with energy and often now people make a very easy and intuitive link between energy and its impact on geopolitics and what's often forgotten – not always but often forgotten is that there is also an environmental element to this energy revolution, as it has been dubbed, and this is exactly the kind of thing where we want to enter the strategic debate here this morning and make that the topic of today and hopefully give you something fresh to think about.

The debate about new or alternative oils that of course in Europe is often taking place is often shortened here in Europe to shale or the shale revolution, often with a nod towards the United States and the kind of impact that the shale revolution over there will have or is already having also on our energy markets and our energy security over here.

That is a shortened debate and what we want to do today is not only look at this one specific thing that everybody's thinking about and has become a bit of a token topic but look at the huge diversity of alternative oils that is already out there, already available, coming into the markets and look at all of those very specific different forms of alternative oil and their environmental impact.

In order to make it graspable and not too complicated these two very fine colleagues here from Washington, Deborah Gordon and David Livingston, have over the last – I don't know – year or two slaved very, very hard to compile an oil index and a new index is just what the think tank world has been waiting for but I think this is the kind of index that will actually not be a nice little number-generating tool or toy but actually something rather useful also for policymakers and for analysts.

So that's what we're trying to do here today, to give you a grasp how each of these individual alternative oils might have an impact in the entire production line from upstream to downstream and how it's going to impact, and then of course what kind of policy conclusions to derive from this. Deb will introduce the index, the methodology behind it, the data that went into it and all of the blood, sweat and tears that went into it as well, I'm sure, and then we have David Livingston giving comments and it's also great that we have Jan Cienski here with us even before Political Europe really starts on 21st, I think.

JAN CIENSKI: Correct. We're getting down to the single days, it's very close.

JAN TECHAU: Excellent, so you've got your blood pressure under control and it's great, fantastic to have you here this morning. You're going to moderate this. Jan Cienski is the security and energy editor for Political Europe, which will start officially on 21st April, this month, as most of you will know. It's great to have you here at Carnegie Europe. I will leave it at this. I hope you enjoy the proceedings. I know that a number of people will show up and trickle in once we've started, that's usually what happens here. Nevertheless, I hope that you will have all the time and all the focus that you need for this topic. Thanks to all of you for coming over, it's great to have you here. Enjoy the day.

DEBORAH GORDON: Thank you, thanks so much, Jan. We had launched the oil climate index in Washington DC last month and the very next place we wanted to come with this, which is today, was to do this in Europe because it's directly relevant. It's really relevant to every geography on Earth because oil's all around the world but it's incredibly relevant to Europe. Europe imports a tremendous amount of oil and has a lot of choices.

So we'll go through, as Jan said, why we thought to do this index, what the index is and then David and I will preview a new web tool that will be released next month that will allow people to dive into these 30 initial oils that we've modelled and start to see how they move around. We're looking at different aspects of the oil value chain, how if you can make different assumptions and different inputs, you can either reduce or even increase greenhouse gas emissions, depending on how you manage these oils.

So it's a tool with many different potential outlets, policy and investor and other decisions [?] and that's what we'll tease out in the second part of this conversation. Just to start, in terms of the oil index itself, a bit of background so the global oil market's incredibly dynamic, as we're seeing recently, high prices to low prices but a lot of the genesis of concern around the oil market was around the 1970s oil crisis. That put security of supply squarely in the centre of what we're going to have to manage, what Europe and other geographies will have to manage in terms of oil. Security of supply is one of the leading factors here.

The second leading factor that has long been in the oil market is the economics of oil; what will it cost to get oil to people. We've come from 60 years ago a very stable price of oil that made the economics of oil not a very big conversation to what you can see here starting in the 70s, cooling down a little bit again in the 90s and more recently a tremendous amount of volatility in this market.

So one node of oil is geopolitics, security of supply. Another node of oil that will always be part of the conversation will be the economics of this whole endeavour but the third one that we've really focused on is climate change because if there's not that third part of this equation it's going to be very difficult to get a durable oil policy and a durable oil enterprise that can make investments that we know can last for 40, 50, 60 years so you need to consider global climate change not just in terms of possible strengths and assets but also in terms of even infrastructure that itself is durable. If you're going to put infrastructure in places where there's going to be sea level rise or if you're going to have infrastructure around permafrost and things are actually going to get hurt or harmed it means the industry's going to be interrupted.

So climate change becomes a very meaningful both production force but also investment force to consider. Those three things together, those three aspects of oil were pushing everyone starting in the 70s toward this. Everyone thought after the interruption of the 70s oil crises and then going through now more volatile oil markets, now this big push about dealing with climate change; the movement was alternative so a lot of policies were developed in the last ten years about oil being displaced by alternative fuels.

But what we really saw in the last, I'd say, five years or so leading with the United States was oil being replaced by oil. That was really the genesis of this project, which was to say, we've got a lot of policies in force that say, how do we replace oil with biofuels, how do we replace oil with electric vehicles? But the reality is the oil market's so durable that new oils will replace old oils and those oils are quite different from each other so you have to consider those from that perspective and that was the idea behind the oil climate index.

So this is what is everything in the oil, in the liquid fuel oil sector is up against, conventional oil, but the reality is that this is a dwindling resource. This middle barrel of conventional pools of liquid oil is what peak oil was all about. The conversation about peak oil and oil going away, it turns out, was not really about oil or hydrocarbon, which I'll show you in a second. It was really about this; there's going to be less and less of this that's accessible that we can get to but this is what it's being... Wait, I'll not say first what it's going to be replaced by.

The reality here is that if you look at all the forecasts on oil, oil is thought to be by mid-century still the dominant fuel source, it will remain the number one energy source but interestingly, the products that come from oil are going to change. There's going to be much more of a shift away from gasoline and more of a shift to petrochemicals and petrochemical feedstock and then also to freight, anything that will move commercial stock so diesel, jet fuel. There's going to be much more of a push to a different part of the oil barrel so not only are oils changing but the products that we want out of oil are going to shift around over time as well in the economy.

This is what oil is becoming. Oil's becoming everything other than what it was so that middle barrel I showed you, the pooled oil, is no longer going to be where this industry is moving. This industry is moving to the opposite extremes of the hydrocarbon world. It's moving to very light, gassy I would call them, things that are like natural gas that you can make a good product out of. We're seeing that with the shale revolution in the [inaudible 00:09:52]. Shale oils are extremely light. Some of the Texas oils are coming out actually condensate, which is a very light end that's not even oil but you can make it into oil. So there are big debates about that, all the way down to, I would call it, more toward some of the coal, we were moving towards solid hydrocarbon, then just [?] to move back into liquid fuels. That's the bitumen in Canada, the oil sands.

Then we were talking earlier about the oil shale paragon [?] which is an immature oil in rock that you can actually advance time and turn into liquids. Estonia has it, Jordan has it, Israel has it, the Rocky Mountains have it. So we're moving more into these extreme places to find hydrocarbon but the problem is managing this and not just looking at replacing oil with alternative fuels because there's a lot of competition first in markets to replace oil with oil. So that was the genesis again for Know Your Oil creating the oil climate index, that if we don't know what we're going for... And we know physically and chemically these substances are quite different from conventional oil and actually quite different from each other. There's a lot of variety in these, the pictures that I just showed you.

It means that there's most likely going to be a very big differences between these substances, these feedstocks in terms of their climate impacts and we want to know exactly how big those were. The climate strategy is very much now around trying to get to some portion of the oil sector, the coal sector, the gas sector in order to manage climate change. We know it's derived from the burning of fossil fuels so the goal loosely out there has been said... About a third of oil resources have to be managed, have to be dealt with, maybe need to stay in the ground or the carbon cannot go into the atmosphere from those.

But this is the real climate index; which one-third? It really matters which one-third you go for, as you'll see in the oil climate index, because if you go for an oil that's a relatively low greenhouse gas oil you're going to get a lot less carbon reduction out of that than if you go to the third of the oils that are very high greenhouse gas-emitting oils and there are quite a few that are very high, for different reasons; high greenhouse gas-emitting oils.

There's at least an 80% difference in the greenhouse gas impacts of the 30 global oils we first modelled through the global oil climate index so the first, this index that can be applied to all oils has 30 oils modelled, as I said. There's an 80% difference. I think that that really surprised us. My researchers, my partners at Stanford and the University of Calgary, when I say us; David and I have worked with these other researchers that have models that form this index. Only 30 global oils, which is 5% of global production, in this initial run had 80%, almost a factor of two in terms of the greenhouse gas impacts. That's huge.

We do know that it's most likely that the ranges are greater because we weren't able to model all the prospective oils that are most likely very high in greenhouse gas emissions but in those oils that we were able to model there's a very big range which hearkens to pick and choose wisely. There's a real investor strategy here, there's an industry strategy here, there's an NGO strategy here and there's a policy strategy here in terms of picking and choosing these oils wisely.

This is where the oil is – I mean the greenhouse gas emissions are. I just want to break this down before I show you pictures of this 80% and some of these 30 oils. This is the oil value chain so upstream the oil value chain is... We found a tenfold difference in emissions in terms of the extraction of these 30 oils so in order of magnitude, between the lowest greenhouse gas oil to get it out of the ground, to extract it, and the highest.

Then in terms of the midstream, which we also modelled, which is the refining of this oil to turn it into the product that the market wants, there was a fivefold difference in emissions between the lowest and the highest greenhouse gas oil of these 30 oils in terms of refining them, the energy required to turn them into product.

Then it's often assumed that the downstream is a number, like all oil is gasoline and all gasoline is one number. It turns out that there is a 50% difference in our 30 test oils between the products that come into the market from each of those 30 test oils so there's even a tremendous amount of variety in terms of the product slates from these 30 different oils.

So when you sum all that together you get this and this is in [unclear 00:15:01] picked it up as well. If you sum all of them together you end up with what we ended up building, which is also in the report, a greenhouse gas emissions supply [?] curve but this is the breakdown, remember, so green is that first bar of extraction. The green here is the variability in upstream emissions to extract the oil. The silver is the variability in the midstream emissions to refine that oil and the blue is the variability in the downstream emissions for the end use of that oil.

We know that the blue will shift further because the first variety of our model had to assume, based on how we built the model, that all of the petrochemical feedstock – and you saw petrochemicals are a growing part of the oil use, oil demand – we assumed in the first iteration that all the petrochemical feedstock goes into refinery fuel gas to create heat and steam to refine the oil. But if you actually pull petrochemicals out and use renewables or very low-carbon gas in you can end up with even a reduction in the blue bars here in terms of end use because more of this balance can go toward a non-combustible petrochemical feedstock because you don't burn petrochemicals to get value out of them so you don't get CO2 out of that.

The last two slides are just to give you a sense of exactly why the market's not going to work unless you not only had an oil climate index, you bring more oils under it and have actual policies to manage what we found, that oils are quite different from each other and you need to manage them carefully, you need to select them wisely in order to strategically get the most carbon you can out of these oils so

you're not putting an undue burden on industry or promising something you can't deliver because all oils are so different that if we're going to march them [?] in terms of their climate impacts we have to be very strategic in doing so.

This is why we can't let the market do this and we need policy. There are two slides that show problems that the market has right now. Production supply; production supply costs are out there now, you can pick them up. This is Reistad [?], Citibank, Citicorp has one. I'm trying to think; there are different IHS; Sarah [?] has one. But basically not only do oils put out different greenhouse gas emissions, which is the oil climate index, they also cost very different amounts of money to get them out of the ground.

The problem is those variations are not in sync so you can find oils that are very cheap to get out of the ground that have high emissions. You can find oils that have higher production costs, that have low emissions so if you're going to allow the market economically to figure itself out in terms of what oils to invest in and what in the short term to take out of the ground and what in the long term to not take out of the ground, that will not be correlated necessarily with greenhouse gas emissions. We might be taking some very high greenhouse gas-emitting oils out of the ground because they're cheaper to extract but in reality they have very high full greenhouse gas emissions. So you need to have more information and policy because business as usual won't consider the climate but investors obviously will go to production that's the cheapest first.

The second reason why you need policy for oil is not just the beginning of the strategy [?] in terms of production costs but it's also in terms of product value on the downstream end use, the end of the value chain. The industry is very good at turning every bit of carbon in oil into product. Sometimes it's bottom-of-the-barrel pet coke and it's not very valuable but there's a use for it. It turns out that a lot of oils that have a lot of value in them in terms of total product value are very high-emitting. You basically get more oil out of heavy feedstock, you get more product out of a heavy feedstock than a light feedstock so you can turn it into more barrels of product. You don't conserve volume so a barrel of oil can turn into more than a barrel of product.

What this shows you is you get more product and more value out of some oils that are very high greenhouse gas-emitting which means again economically there's a real push to taking some oils out of the ground that are very highly greenhouse gas-emitting and then there's a high product value to some of the highest greenhouse gas-emitting oils. So the market is pushing toward a higher greenhouse gas world in the oil world and not a lower greenhouse gas world, which is why we so desperately need policy here to at least price carbon, cap and trade carbon – we'll talk later about different policies – but you need policy in order to restructure this market to consider climate and not just user [?] economics.

That is the end. We can certainly go into more questions about the index. I didn't want to walk out on you, which I can be known to do. We're going to just show you – this is the wonky [?] part actually but it's an animated wonky part – to show you the web tool that's going to be coming that will allow folks to either enter at a very novice level or through the web tool go into the models themselves. They can actually dive into the models themselves and change assumptions and forecast and do things and see what comes out.

I should say – I didn't say it up front but I think it's one of the most exciting parts of this project – we used an upstream model called Objet [?] which comes out of Stanford University that's used by the European Fuel Quality Directive and by the California Low-Carbon Fuel Standard. Adam Grant, the

developer of that model, is one of our co-authors and it's fantastic and he has grown out the model and expanded it through this project.

But we also, through my other colleague, Joule Bergerson, developed the first open-source refining model as part of this project so that up to this point in time if any of you ever wanted to understand a refinery you'd have to spend hundreds of thousands of dollars to model it. That's actually going to be open-sourced in this project, the first ever, which I think is fantastic because the refining sector has a lot of questions from Europe and elsewhere about the refining sector and the future of it and how to manage it so I think that will be really helpful.

Anyway, this is the web tool. What it first does is it builds this emission supply curve that I was referencing, where the colours are categories of oil based on their oil-emitting categories so with the greens you'll have the light oils, you'll have the more conventional oils. Those are the lower-emitting oils and then you have, the blues get into watery oils. They can either be depleted and watery oils, they can be deepwater oils and then the dark charcoal are the extra-heavy oils. So you can see the marching up of different emissions and then this is the current production value that we have.

What we'll do with phase two is we want to also match this with the resource capacity so it's not just what you're producing today, it's how much reserves of these oils that tells you a big part of what their carbon potential will be so we'll do that in the second version. But we have our 4.5 million barrels of oil in these first 30 oils that we've modelled and there's a range of about 80% in terms of their emissions.

The next tab is comparing oils and you see where the oils are in terms of the three different metrics we can sort them by. The default is by greenhouse gas emissions per barrel of oil that you're going to produce. You can re-sort them. David, do you want to do megajoule? You can do greenhouse gas emissions per megajoule of oil. This is how much energy comes out and then you can do the greenhouse gas emissions per dollar value of product [inaudible 00:23:12] at the end and you can see how much that flips the oils round when you look at them in terms of their emissions per value of what they produce to the economy.

We can also delve into where the emissions are hidden in this oil supply chain so this is the total emissions. You can do upstream and you can see where the oils re-rank when you're saying high to low in terms of their upstream emissions, their midstream emissions and their downstream emissions. Then you can sort them by oil type, which I was just showing you, comparing oils to like, very, very similar oils. Then you can sort them high to low and low to high so you get a different sense of where you are.

What this lets you start to think about is where do I dive into each of these oils in terms of reduce their greenhouse gas emissions because there are two reasons why you'd ever save price [?] carbon. The first one that the world started with, which is a much harder task, is to say, what price carbon do I have to put to get alternative fuels into the market or people out of their cars? That's the demand response; very, very high price in order to get people out of cars, to get people not to buy cars, to replace all cars with electric vehicles. We've seen that is an extremely high price. Even $100-a-barrel oil wasn't really enough to turn on much of anything in that regard, or very slowly turn it on.

But also the second question was what is the price that you would have to impose on oil in terms of a carbon tax in terms of cap and trading to actually shift the supply of what investments would be made by the industry? You can start to see that there's a lot of variety here so it's a much lower price on the

margin to get different decisions made upstream, midstream and downstream on these oils to start to cut and nick away at the carbon that's embedded in these oils.

So then the next page – let's go to drivers first. Drivers starts to plot where these oils stack up in terms of specific aspects of what make these oils different and the one that I wanted to explore – we had eight drivers in the final though it's being coded right now so there'll be more things to sort them on but gravity is a good one just to show you now. Gravity's interesting because up until this point in time API gravity is the weight of an oil and it's how the oils trade. Oils are traded based on their gravity, how heavy or light they are, and on their sulphur content. That's the big thing that creates value in the market right now; very simple.

So for a long time it's been assumed heavy oils are high-carbon, high greenhouse gas and light oils are low. It turns out, you can see in our sample oils here – the light green are light oils and the grey are heavy oils – you can see there's some reality to that but the real reality to that is out of these 30 test oils there's a lot of variety when you look at the gravity of these oils. We can't say these gravities determine greenhouse gas emissions because there's no correlation between oil and its gravity.

If you look upstream – go down here, David, to upstream – you can see again if you look at extraction greenhouse gas emissions and you're looking at gravity, there's no meaningful way to sort oils and say, we have to somehow attach a fee or discount, high oil sands. Oil sands are the only problem. The reality is there is a lot of opportunity here to get to the carbon-bearing nature and the greenhouse-gas nature of these oils and gravity will not do that for us. Another breakdown and how the simple information in the market right now really doesn't help with climate change.

Then you can go into the model parameters so go up to the model parameters and let's see. Actually I think we decided this shows better. Go back to – oh, it does. This gets you to be able to start to see whether – yes, do flaring. Flaring's a big problem in terms of... I'll tell you, there are four categories of oil which will give you a sense here. There are four categories of oil that we had figured in and computed in our model that were the most difficult to manage in terms of their greenhouse gas emissions. One of them is gassy oils where the gas is not sold but flared and burned off and that's what you're seeing here when David moves the flaring ratio. So if we can make all gassy-flare oils operate like Norway operates, which basically in the 70s said it's illegal to flare gas... We don't do this in the bulk of [?] North Dakota, we flare gas; Nigeria flares gas. Everyone around the world tends to flare gas; Russia certainly flares its gas and Norway doesn't so Norway has a gassy oil that's actually very, very low greenhouse gas-emitting so that's an easy thing, to start to figure out what to do here.

This lets you play with it. The second category of oil that was very problematic for us was watery, depleted oils. Oils with a lot of water in them and less oil remaining in the reservoir means that you have to lift in some cases 15 [?] barrels of water to get one barrel of oil out. It takes a lot of energy to do that so depleted, watery oils – Indonesia has them, California has them – there are a lot of depleted, watery oils that are very problematic.

The third category of oil which Europe has zeroed in on already is the ultra-heavy oils, especially the oil sands, which have a lot of carbon so that was a problematic oil in terms of greenhouse gases. Then the last category of oil that we want to delve into more in terms of land use is oils in extreme environments. We have China, Russia – Russia's Bakunin [?] field here that's 35,000 feet deep but the Arctic oils will have real problems in permafrost. There's development in areas that are highly forested. Those are going to be difficult oils to deal with in terms of greenhouse gas emissions too so those four categories of oil will have more parameters to play with but you can see why we picked these parameters. Water intensity was one because it's very much related to greenhouse gas emissions;

flaring is another which is very much related to greenhouse gas emissions. So you can start to see what policy levers might do if you can reduce flaring, reduce steam input; you can see what they do in terms of greenhouse gas emissions.

Then last but not least, which one did we decide, Indonesian dirty [?]? Here you can go into an oil itself and get information on that particular oil. Up until now it's all been about the tool which is comparing oil to oil, which is very much what the story is here but in order to get information on that particular oil you can go here and see factors about the oil, its gravity, its depth, its production, its location; you can see where its emissions are now and then you can play with ladders [?] and see how its emissions change so change the steam to oil ratio here because this is a high-steam oil. You can see how – you're looking at the top bar here – how emissions change when you change how you generate your steam.

So Indonesian dirty, for example, might be a great example of where renewables work in the oil sector, that if you're going to generate your steam using concentrated solar you've done a tremendous job just doing that by bringing renewables into the oil sector, which is another conversation. But in addition to that you're reducing your emissions because you're not using gas or pet coke or coal to generate steam to get that oil out of the ground so you can start to see where those policy levers are.

I think I've given a...

JAN CIENSKI: Yes, I think questions [unclear 00:31:01]. Thanks again for asking me to moderate this panel and for the first question I'd like to ask David; Deb talked a lot about potential policy levers and how industry and government could use this data but first of all, are you seeing anybody starting to use this kind of information and what potential do you see for it shaping public policy?

DAVID LIVINGSTON: Thanks, Jan, and thanks also to Jan Techau and to the team here at Carnegie Europe for hosting us. I think Carnegie Europe's profile in terms of strategic thinking on Europe's challenges – and that's across the security space, foreign policy space and increasingly the energy space – is unparalleled and they're doing a great job here.

I think the question you ask is important and it's relevant of course that we have someone from Political Europe here right before Political Europe launches because at the end of the day you can force data into the market, you can force data in front of policymakers but it's politics at the end of the day that decides this sort of thing.

As Debbie alluded to, what's really interesting about this project is that even as we're developing new information and new data some of this has already been integrated in some fashion into an existing EU policy which has undergone a lot of debate over the last several years and that's the European Fuel Quality Directive. So the justification behind the EU Fuel Quality Directive was that, as Debbie talked about, it's inefficient to just address the transport sector or transport fuels and oil via a carbon price. You could put it into the existing EU emissions trading system but the problem there is that the carbon price needed to incent [sic] fuel switching, for example, in the power sector is very, very different than the carbon price and much lower than the carbon price which would be necessary to actually have an impact on the emissions and on technology choice and on fuel choice in the transport sector.

So what you would do, when you include the transport sector writ large you include all oil and all oil products into an emission trading system, for example, or into a single carbon price across the economy you do possibly get efficiency gains in the short run because you're looking at the lowest

cost mitigation option but most of the mitigation will flow away from the transport sector into the power sector and to industry where there are lower cost mitigation options available on climate change.

So if you truly do care about long-term change and you truly do care about changing infrastructure decisions and changing long-term investments then there's a bit of a disconnect there because you're building up to the low-hanging fruit in the short run but you're losing sight of long-term or systemic change. So I think that was the thinking behind Fuel Quality Directive, that what you would have is a policy where you would require the carbon-intensity of all the transport fuel sold within the European Union to decrease incrementally year over year and you would give industry multiple different options to achieve that. You'd allow them to switch from higher-carbon oils to lower-carbon oils, you would allow them to sell more biofuels or even more electric fuel for electric vehicles, or you would just have them reduce emissions associated with refining with the transport and with the marketing of those fuels.

This was very, I think, laudable and eerie [?] and it had merit in terms of the ambition of this policy but it ran into a number of challenges that were both external and internal. Externally the policy was seen by some as targeting, for example, the Canadian oil sands. The reason for that is because there was insufficient data to represent the full heterogeneity of emissions of various different oils globally and so what the European Commission did is it targeted conventional fuels as one basket and then it had a few categories of unconventional fuels that it gave higher emissions-intensity ratings to. So it had all conventional fuels, then it had the oil sands, for example, not necessarily in Canada but Canada's the largest producer of these oils sands. Then it also had oil shale and oil shale, as Debbie mentioned; there's a large resource base in Estonia and so even within the EU, though it got less press, behind the scenes there has been a very difficult political battle even before energy security was pushed to the forefront by the Crimean crisis, there was a bit of interplay in the background, especially at the European Council level, between Estonia and others who were more enthusiastic about the Fuel Quality Directive because this would perhaps not ban those high-carbon fuels from the EU but would make it more difficult for them to enter the market. They would have seen a discount in the market.

Then on the Canadian side, of course, there were threats of action being taken at the WTO. I was working at the WTO at the time and I can attest that there was a lot of catching up, people doing their homework on what exactly is this Fuel Quality Directive and what if there actually is action at the World Trade Organisation and is this a defensible policy or not, will it meet its environmental objective and does it discriminate unfairly or is it really making these choices on the basis of environmental policy?

I think that regardless of what you think about the merits of the Fuel Quality Directive and Europe's past efforts, what it's really suffered from is a lack of insufficient data [sic] and that's the difficulty of finding out where these oils come from. So I'd highlight that there's immediate action that can be taken on the policy side, maybe not to design the perfect policy today but to enable that policy to come into place later. I think the importance of data collection can't be underscored enough so for example, when oil enters into the European Union it's mandated that the origin of that oil is reported.

But in the lead-up to the fuel quality directive what we have is a situation in which when oil products enter the European Union, so when petrol or diesel was imported into the European Union market there was no requirement for the origin of the oil used to produce that petroleum product being reported and we didn't know the origin then. Similarly when you had intermediate feedstocks that would go into refineries so you would have some naphtha or various different petroleum products

which would not be sold onto the market but which would then be put back into refineries to help refine other oils; when those would be brought into the EU similarly the origin was not reported.

This was also true of feedstocks that would go into petrochemical processes, which also eventually might end up being feedstocks for transport, of course. So what you have is a sector which, unlike coal or gas or others, which is global, which is relatively liquid, globally traded and which has products at multiple different parts of the value chain that are traded amongst themselves. So I think the challenge here and the reason that it's so important, I think, to make this a broader discussion about the Fuel Quality Directive, about similar emissions intensity standards – there's one in California – looking at opportunities to link these and to make them more coherent and to ensure that they're not trade-discriminatory and to ensure that they'll be robust and stand the test of time, is because the problem is global and you can start to regulate it on a local level or a national or even supranational level like at the EU but at the end of the day this is a discussion that has to be made a priority by the EU, by the US, possibly carry forward to Paris later this year and look at opportunities at the beginning, before we have the data to craft the perfect policy, to collect the data necessary to enable us to address oil down the road.

Oil and the transport sector will possibly be one of the most durable aspects of the fossil fuel sector, simply because we don't have immediate, scalable alternatives to oil and to fossil fuel-based transportation systems at the moment and so I think we have to see this as a long game and we have to put in place the infrastructure at a global level with governments leading the way and then industry following the rules they set but with governments leading the way on getting the data necessary to be able to implement these regulations down the road.

JAN CIENSKI: So have you talked to people in Washington and Brussels about the index, what's their reaction been and can you see them start to incorporate some of the findings of the index into their policies?

DEBORAH GORDON: The initial talks have been in California because of the low carbon fuel tender that David mentioned and what we're finding in the US – it might actually be better in Europe – is that the energy policy oversight is extremely fractured in the US, whether you're talking about Federal government with the Department of Energy or in California with the California Energy Commission; the reality is that energy policymaking in the US is really post-1973. It hasn't been around very long and it's very much around security of supply and perhaps price of fuels and forecasting in that regard. So we have a much better audience in the Environmental Protection Agency on the greenhouse gas side, or the California Air and [?] Resources Board and we have started to talk to them because we don't need that much information or secret information from government in order to do the oil climate index. I think that's a real point.

The information that we need is provided for in the marketplace in order for companies to market their oils in the first place. They have to provide these oil assays and it's just a breakdown, a chemical assessment of what this oil is so we want oil assays provided in a consistent format and that's the message we've taken to government round California. We wanted to start with California and then if we can get breakthroughs in California, the way the States work, on anything climate change you get breakthroughs in California first and then you try and move it into the Federal government as well. It's like a slower movement but we have also been thinking about working at the other end as well so starting with, in California, the state, trying to make transparency around these oils far greater, run them through the index.

But then also working through Paris with international stakeholders because it's interesting to my mind that China and India aren't really high on transparency in general but the world needs it across the board but on oil they are. These are countries that want to know about oil, they don't have a lot of oil, they need a lot of oil, they want to know a lot about oil so it's one part of this transparency conversation that could be a leading edge in Paris on, for climate purposes, transparency on oil is something that you can get in US, China, India, Europe – big importer – to care about.

So the conversations have been good, they've been, oh, we didn't know there was that big a difference in oils. It was that awareness of, we've got to choose better.

JAN CIENSKI: One of the reasons you went down to 30 oils was simply that the data you had access to was so wildly varied that it was difficult to use a full sample. Is that something that you thought you'd persuade regulators and governments to do, to come up with a single or more transferrable standard that you could use to create a wider index?

DEBORAH GORDON: Yes, absolutely and I'll explain; we have no fracked, Vulcan, Eagleford, US oils in here. You probably didn't real but it's in the report, you can read all the oil names. The reason why in phase one we don't have any US lifetime oil is because we don't have oil assay for them. The reason there's no oil assay for them is – this is ironic – they didn't have to market that, they can't be exported because US has a crude oil export ban and there was such a high demand for them when they came out of the ground that there was a speedy, rapid marketing that didn't go global.

So the US oils haven't gone global for policy and other reasons but what is reported globally is these oil assays are in the public domain. We collected hundreds. Ahmed [?] collected many hundreds of them actually but they're all measured in a different format. There's no difference other than basically what you're doing in the oil assay is you are simulating what the oil's made – you know what the oil's made out of and you're putting it through a simulated distillation process and you're cutting, at this temperature this will happen, at this temperature this will happen. You have these temperature cuts. The problem is that you don't have the same temperature cuts for oil assays, you have to make assumptions to make them standardised and those assumptions introduce a lot of error. What you want in an oil index is comparability, you really want to be able to say, we really think this oil is 5% more than that oil.

But if you start making these assumptions you've made that fuzzy so all we really need is the same temperature cuts and they're random and there's no good reason why they're random. They're probably a little bit randomised based on what refinery you think that oil might go to and a lot of the oil assay, like everything else in oil, was set up around the 20th century of oil. It's not set up around what oil's becoming, it's set up around what oil was so this is just the first of many things that are probably going to have to change in the oil sector to set the industry up into managing this whole new array of oils that are coming out of the ground.

What are the prospects? I think the prospects are better than good and the reason why I say this is it's not just for green house gas emissions. You need good oil assays for rail cars that don't explode. The reason why rail cars are exploding in North Dakota and Canada is because the handlers didn't know what oil was in the rail car because there wasn't really good data on that oil. So you need this information for safe handling, for safe operations, for greenhouse gas emissions and for investors to decide how much this oil [inaudible 00:45:53]. So I think those forces – oh.

You also need this kind of information or the tracking of oil in terms of black markets for oil so if ISIS is selling oil and you want to know whose oil ISIS is getting you really want this kind of information because you want to be able to track this oil over time even for security purposes.

JAN CIENSKI: One of the other things that really pointed out the difference between the oils was flaring so how do you measure that now, is that publicly available, are the Chinese and Nigerians...? I assume the Norwegians, since they don't flare, that's fine but how do you get the data and what are you going to do with that in the future to improve the data that you've got?

DEBORAH GORDON: It's a great question because there's a real part of this both for flaring and for land use, the extreme oils; I explained. There's a very big use for satellite information there. The current data comes from literature largely and industry reporting on flaring; who's doing what. It is out there a little bit but it's a bit spotty and we know Iraq flares a lot of their oil, we know Russia flares a tremendous amount of their oil. The Vulcan [?] have been flaring a lot of their oil, they don't have gas handling infrastructure up in North Dakota. So the oil's worth so much, the gas isn't worth so much. They've been burning off the gas and wasting a sizable part of their investment. They're just burning it up because they make so much money taking the oil out of the ground.

This ultimately can be managed by satellite data and NOI has a satellite, the National Oceanographic Institute has a satellite and in the next phase, phase two of the oil climate index we're going to sync that satellite data to knowledge we have of regions that flare and see. We need to correlate this better. The satellite passes around Earth once a day so you can get a bulk of data and a lot of this, I think, is moving into the metadata handling of the world. There are many firms now that love data. The data itself will give new knowledge.

JAN CIENSKI: My understanding as well is that the model is robust enough that you don't need every single parameter to be able to construct it, that you need just a handful in order to get useful information out of it.

DEBORAH GORDON: Yes, this is true of the upstream model so the extraction model that has the biggest range of emissions so it's a very, very important part of the whole oil supply chain to get a handle on extraction because you can have an emission of one and an emission of ten, it's a huge variability there. That model, Adam Grant's model from Stanford, is the oldest model that we have, it's been around for about six or seven years. It's used by the California Resources Board and there's been...

In fact I just found out that California has modelled the upstream emissions for every California oil so we're trying to get the oil assays so that we can run every California oil through the oil Climate Index, which I think would be very important for the state to understand what they're doing. But the model was designed over time with a lot of analysis that a little bit of information will correlate to other information and so a little bit of information works with the other information that the model has to improve upon itself. So it's a bit of a dynamic model so you don't need to know everything about the oil, every last bit of information to make it accurate and it gets more accurate the more information we get over time.

JAN CIENSKI: I'm curious about the industry responses because my feeling would be that if you are producing some of the higher greenhouse-emitting gas [sic] fuel that this would not be information you'd particularly want out there because it could effect the value of your company, it could affect the marketability and the sale price of your product over time as it became more widely used. Are you seeing some push-back from companies like [unclear 00:49:48]?

DEBORAH GORDON: Exxon was actually quite active on this process. We had a workshop with stakeholders. Exxon and Chevron and Shell were all there. I don't think it will be the majors necessarily that this is going to hit the most. First of all, to be very fair, most of the world's oil is in the hands of the national oil companies so this really goes deep down into Petroba, Send [?], into Russia, into Amanco [?] and one or [?] two other places. Then what we've seen in Vulcan and Eagleford is this isn't even about the majors, this is about wildcatter independent oil companies.

The other thing, to answer your question, is the information that we've really brought to the fore has nothing to do with any particular company. These oils can be owned and swapped and disposed of readily by companies depending on how those companies – and companies trade their oil plays often. They won't necessarily remain in an oil play and in fact one of our oils that we have that was one of the higher oils in California, South Bellridge; I did some digging. It was an Exxon oilfield that has long been an Exxon oilfield that was just last year swapped with a company I'd never heard of so I was really curious about this. It's interesting because if Exxon was even paying attention to this they'd do the right thing for the climate by saying, we're not going to produce South Bellridge, we're not going to be involved in South Bellridge.

It was bought however by a company called Linn [?] Energy and when I did some digging on Linn Energy I realised this was going to be a very interesting, fascinating world that this information's even more valuable for. Linn Energy's a master limited partnership, it's not an oil company. This is owned by an investment arm, basically an investment firm so if the investors think that this is a good investment they'd better figure climate into this as well.

So I think that this world is getting only more... You have the traders involved. You're getting a reintegration in a strange way of the original oil industry from 100 years ago. It's now independents, it's countries, it's major oil companies, it's investment firms. There are so many entities that are involved in this that I almost don't know who will push back on it because some of them are going to get information out of this and some are going to give and it's a little bit... The industry's heterogeneous like oils are, which helps. It means that you need more information.

JAN CIENSKI: And because you're not reliant on industry supplying you the data to create the model you're basically dependent, even if specific parts of the industry are not very happy with what you're doing it doesn't really affect you, it doesn't need it [?] for the model to work.

DEBORAH GORDON: Right, exactly.

DAVID LIVINGSTON: That's right, but the other thing that I think is important to emphasise about this is that there are systemic changes going on in the energy sector, in the oil sector and in the way that oil companies are expected by civil society, particularly in the United States and in the EU, to engage on the climate issue and I think we see that. It's very timely; this week on April 16th at the BP annual shareholder meeting there'll be a shareholder vote, a very historic one on a climate resolution which has been put on the agenda which'll require BP to, amongst other things, if it passes, be much more transparent with the climate impact of its operations. That would obviously include the variable climate intensity of its different fossil fuel assets round the world, to talk about what it's doing on renewables and alternatives and to generally just be more transparent and more engaging with outside stakeholders and the shareholders on how it's managing and how it views climate risk going forward.

Next month there'll also be a similar one that'll be brought to Shell and what you might expect me to say is that these companies have fought it tooth and nail because they see it as threatening their core

business operations. But the surprising truth is that both Shell and BP have endorsed these resolutions. They see them as non-confrontational, as constructive and what I think that indicates to you is that we're starting to see very quietly – and we'll only know it in retrospect after it's happened – we're starting to see a little bit of a phase change and a little bit of a threshold and a tipping point in how companies are engaging on the climate issue.

What the Oil Climate Index offers is a third way between the camp that says fossil fuels will continue in perpetuity, that oil will always be a dominant fuel, that climate is not a priority, that we have to prioritise economic growth and energy security over climate, and those on the other side that believe in shutting down an oil-based economy tomorrow and that discount the large adjustment costs and the large shocks to the global economy that that would bring.

So you have the divestment camp on one hand and you have fossil fuel advocates on the other hand but this is a third way that offers companies the ability to say, okay, if we'd all agree to perform in every operation in the world, whether it be Nigeria or china or Venezuela or Azerbaijan, the same way that we've been operating for 30 years in Norway we can show significant improvements in the climate intensity of our operations, we can show real engagement, we can satisfy increasingly the institutional stakeholders, the pension funds, the hedge funds, etc, the activist investors that are asking us to engage on these issues. So I think that's the real opportunity for this with oil companies.

JAN CIENSKI: Are there similar indices to this in related fields like coal or natural gas and can you see maybe not using obviously the exact, same criteria but a similar approach to assess the full environmental or the full GHG impact on everything from wind to solar to coal mines to allow policymakers to get a much better sense of, does it make sense to build solar in the Czech Republic, for example, or does coal in a modern coal plant make more sense?

DEBORAH GORDON: On the edges – you are right. These models were really about oil, particularly oil extraction, oil refining; very different than you have in coal or gas; and then oil products, which are obviously different than coal or gas, going into different sectors. But what is on the edge of this – and we haven't modelled haven't yet and I would put this out more in phase three – is coal to liquids and gas to liquids are going to be – they already are but will be moreso replacements for crude oil and hydrocarbon. Understanding those and building those in the model will give that type of need to bring coal and gas into this oil climate index over time.

But beyond that, having the stratification and the disaggregation of understanding how big is the variation of different coals and what are the hidden ways beyond flaring and venting of managing gas better. I think it's going to be the way of the future. I think this is exactly what David said, this middle road that we're in right now, that there' this growing awareness that you have to manage climate and a reality to managing climate but the ultimate, penultimate get off fossil fuels is a very long road.

So getting to that road has to do with how to manage what we have better and better and not get into plays that we can't manage and not go there until we can. So it puts this race to the top and I do think it's going to be worthwhile to do that for other sectors. Life cycle analysis has started to do that so I remember the life cycle analysis of the solar cell. I've seen those types of things there but bringing those up with new technologies and keeping them refreshed, I think, is going to be very important.

JAN CIENSKI: The idea of feeding in to make them correlate in some sensible way with your index so that it's relatively easy to postulate [?] particular [overtalking]...

DAVID LIVINGSTON: Absolutely, and the thing I'd say too is we're getting close to the point where there'll be another tipping point and that's where you have an energy storage technology that's cheap enough and that's light enough and that performs well enough that you have innovators like Tesla and you have innovators like BMW that can put that into a car and can all of a sudden make electric cars truly competitive for the mass of consumers in the EU and US initially but then also the Chindia market, the Chinas and Indias of the world.

At that point what you have is you just crumble the wall that's divided the transport sector on the one hand and the electricity sector on the other hand, where we typically say, okay, gas, solar and coal are all competing against one another in this electricity market but oil has enjoyed a virtual monopoly in the transport sector for so long. As soon as you start having the electrification of transport this changes everything and then it becomes very relevant to compare, okay, your electric fuel is not carbon-free, it's running on something so what's the grid mix, is it solar, is it hydro, is it wind, is it coal and what're the complete embedded emissions within that system, including the emissions associated with the construction of the battery and the construction of the vehicle, which I think are not negligible and have to be taken account of.

But I think what we're all getting at is the importance of the life cycles approach and this systems approach to looking at energy because I think if we're seeing anything over the next ten to 20 years it's the tearing down of walls that have divided various segments of the energy sector for so long and the integration of things into operationally efficient, optimised [?] systems.

JAN CIENSKI: Good. I think we've got a couple of mics in the hall and if anybody has questions from the floor it would be a time to take them.

JENS HERKMANS: Thank you very much. 28. Andrew Folkmanis from the European Commission in DG Energy, one of a number of colleagues here. I see some others in the place. I just wanted to comment on David Livingston's initial view on security because you're looking at climate and if you look at the 2030 package, yes, it builds on the previous 2020 targets taking us towards 2027 but it also includes an important aspect of security, looking at security as interconnection and if you go right to the end of that paper you will see a section on governance. In that governance you have indexes, indicators which are still in development from our side, the member states have asked us to develop those and security, safety will be part of that.

So when you say you're going to develop your index further, perhaps one dimension you should look at is to understand how it fits in the, shall we say, broader set of indicators, including the security dimension for oil but of course for others too so looking at the big picture.

Open information is very good and very delicate and difficult in the energy sector so I think also in the spirit of 2030 it's good that you're pushing the frontier on that.

Finally on innovation and innovative processes, we do have an R&D programme and the R&D programme at the moment doesn't really do very much in this fossil fuels area. Maybe it should do a little bit more to look at innovative and hybrid processes and I think generally we would welcome that because perhaps CCS would be a step too far too quickly, and smaller steps to cleaner, CO2 clean pools [unclear 01:02:08] clean is the way we need to go in that sector; also innovative processes so pointers in this direction are welcome too.

DAVID LIVINGSTON: Absolutely, if I can just agree wholeheartedly with that. I think when you mentioned the energy union project, when you mentioned the 2030 goals, when you mentioned that

paper, Jens, one thing that comes to mind that very aptly describes the Oil Climate Index is that the Commission – very interestingly, for the first time – does really put an emphasis on governance and not just the hardware, as they put it in the paper, of pipeline interconnectors, not just hard infrastructure but they also look at the software of energy governance and put equal importance on the software aspects of a well-functioning energy market and a secure, safe and affordable and clean energy market in Europe. So I think that the right way to conceptualise the oil climate index is actually just that, not a single piece of policy but an underlying software that enables us to make better decisions across multiple different issues areas and multiple different policies.

The other thing I would say on the innovation side of things and we talked about it a little bit in the initial presentation but opportunities in the upstream are very significant and I think ways to incentivise oil companies, which are not going away any time soon, and which regardless of your ideological viewpoint will inevitably own a piece of the future energy system whatever that energy system looks like, incentivising them to develop the capabilities in-house to do this and to make the deployment of renewables and alternatives and the reduction of carbon emissions in the road sector a profitable activity is important.

So in California there's a firm I've spoken with before that's doing some really incredible things in terms of concentrated solar power, generating scheme for enhanced oil recovery. Their two biggest markets, interestingly enough, are California and Oman and you could argue that there are no two more different markets than the perennial oil consumer of the last 50 years, California with its freeways and with environmental awareness and a green movement that runs all along the Pacific coast, and then your canonical Middle East oil producer. But the Sultan of Oman has made a major commitment to this and it just shows that there are technologies that can appeal to national oil companies, governments and also private oil companies. The key is for policymakers to listen to that, to realise it and to put in place incentives that make that a profitable activity.

JAN CIENSKI: I think we had another question here.

FABIO MARCHETTI: Hello, Fabio Marchetti, I represent ENI, the oil and gas company. Just a comment; we seem to imply that electrical vehicles are the best solution for the future but we assume the energy mix is key and an electric car component will be much more polluting than a normal car in Belgium [?] or [inaudible 01:05:19] car with more balanced energy mixes is better so I think we should keep that in mind and there are very good alternatives like gas in vehicles and many companies are investing in that because of its more appropriate footprint.

Just a question; is there in the modelling a way...? For example, in Nigerian oils or in Congo-Brazzaville, for example; we have a zero-flaring commitment by 2017 and a lot of the gas flared, we have built gas-powered generation. Is there a way to factor the activities that a company does, for example, to have zero-flaring and the fact that the generation is much cleaner than charcoal, for example, that was used in some of these areas. Is there a possibility to put that...?

DEBORAH GORDON: Yes, it's in... When you're playing with the tool you can adjust flaring down to zero so our figure was 10%. You can never say flaring's zero because it's there for emergency purposes but Norway is basically almost zero so you can show how those Nigerian oils, if you were to operate them like Norway's oils, you could see how it reduces the greenhouse gas emission impact so that's there in order to forecast and make commitments. It'll be fantastic to get more of those commitments out there.

I think your original question follows on what Jan was saying in terms of building this metric out ultimately to be able to compare those different power generation mixes that would go into comparing the equivalent barrel of oil that you were displacing; how would that be for an electric vehicle depending on where you are and your commitments made.

I guess the one thing I'll say about electric vehicles is that it might not be in every location a short-term reduction in greenhouse gas emissions but it is the bridge, electric vehicles are the bridge to renewables in the transport sector. Biofuel's from a different angle but electric vehicles for solar, for wind; that's the best bridge. We're not going to have obviously those renewables in cars themselves.

DAVID LIVINGSTON: Yes, and I think the life cycle analysis and comparing apples and apples and not apples and oranges is incredibly important and I fully agree with you on that. On different commitments and on this notion that I think we haven't emphasised enough, the fact that all these numbers shouldn't be interpreted as final point estimates but they're just best estimates of a certain point in time which really should be thought of as best estimates within a range. There's a range because even within a particular oilfield there can be different operations, there can be different operations, there can be different technologies being applied and so you're bound to have some variance and so there is no final number associated with an oil.

It is very much going to be dynamic and changing over time so I think it's very important to have this project as an open and regular dialogue with industry so that we're making sure this is consistently updated and reflecting and encouraging companies to come forward and race to the top in terms of disclosing best practices and what they're doing in various regions around the world and how some of these might change some of these best estimates in the index.

JAN CIENSKI: A question here.

JIŘÍ JEŘÁBEK: Hello, I'm Jiří Jeřábek from Greenpeace. I have one question and one comment. You mentioned something about the permafrost so do you in fact include the leak of methane in there, do you include also the land use changes and also methane leaks from mining, from drilling?

The other is that not only climate impact should be considered by looking at oil. As Greenpeace we are now criticising the oil drilling in the Arctic because there is also a huge danger in this extreme environment of leaks, accidents and environmental destruction, not only the climate. Thank you.

DEBORAH GORDON: Yes, no, very good questions. Adam Grant's chief upstream model, which is where these types of issues – I guess venting and flaring is probably everywhere but in Adam's model the venting and flaring and the methane leaks [?] are included. The land use is pretty cursory. We have, I think, three levels of disruption that you would find in land use so what we wanted to do in phase two; you have a very low impact, a moderate impact and a high impact so it's there but it's a first phase.

What we want to do in phase two is use again satellite data in terms of actual disruption in terms of land use and also use satellite data in terms of the venting and the flaring so you can start to read these things from satellites and monitor them and see if they correlate well with what actually is being permitted to be done or how things were supposed to be operating. There'll be more of a verification aspect through satellite data so yes, land use, venting, flaring; all critical and all in the models and all due to be improved upon over time, which brings us back to the last point that this is a work in progress that gets better over time, you get better information over time.

On the infrastructure question, talking about pipeline safety, etc, again I think a lot of that goes to not just the question of operations but back to the question of transparency; what's in this infrastructure? Whenever a pipeline breaks in the US, in the last couple of years and we were moving diluted bitumen, the local authorities didn't know it was diluted bitumens in the pipelines in Arkansas that broke. The problem is that if you dilute bitumens you've taken this extra-heavy painting oil and you put very light [unclear 01:11:28] into it and in the pipeline it looks like oil, it might as well be conventional oil but the reality is you've basically taken hardened paint and paint thinner, mixed them together and you're treating it on the wall like it's real paint but in reality when it's exposed to the environment the heavy sank and the light evaporated and it didn't act anything like oil.

So I think that you need this transparency of what is – know your oil. Greenpeace, others need this transparency in terms of how you respond to these kinds of infrastructure management issues and handling that and in a case where there are problems you need to know what's in the infrastructure in the changing world of oil to be able to safely deal with it. That information is woefully inadequate at this point, it's all pretty much still assumed to be conventional oil, that's what the world is moving [?].

I'll tell you why. The reason why we're fighting this battle has a lot to do with public perception that gasoline and diesel haven't changed very much; yes, it's lower-sulphur. But the public's been handling gasoline and diesel for very many generations and the change hasn't really shown up at the end of the pump but there's so much change at the front end that those questions have lagged. So do I think NGOs are going to need this information, regulators are going to need this information, operators are going to need it, which only pushes the question that Jan had earlier in terms of how much fighting, push-back will there be on transparency. I think the usefulness is going to be vast because we live in the 21st century world where people want information and anyone who discloses it; the assumption is that you must be hiding something.

JAN CIENSKI: On the land use again, you're not really looking at things like cut-down forests or anything like that. You're looking at GHG emissions related to whatever you're doing to the land, permafrost or whatever, what's released by whatever it is that you're doing.

DEBORAH GORDON: Yes. So there're some very early models, they hearken back to some researchers from the 90s and 2000 and they've been slightly improved upon, that start to go into land use disruption and what that meant for the carbon-carrying capacity of permafrost or of forest. All of that can start to be analysed through satellite data.

JAN CIENSKI: Any more questions?

NICOLA WATERFIELD: Hi, Nicola Waterfield from the Canadian Mission with a question about petroleum coke. I think your model captures the combustion values of petroleum coke whereas in some cases pet coke can be stored or buried or it goes in [?] with coal so the net change in GHG emissions wouldn't be as significant. I'd be curious to know how you came to capture pet coke the way you did in the study, the entire combustion value and if there might be scope in future models to address some of the different treatments. Thank you.

DEBORAH GORDON: No, that's a very good question. Let me explain to folks what petroleum coke is. Pet coke is the bottom of the oil barrel. When you've squeezed every bit of liquid you possibly can through current processing techniques out of that oil, whatever oil you get, you basically get some leftover carbon, it's residual. You can't turn everything into liquid fuel and so the pep coke is an analogue to coal, it's the coal that's left over, the basically pure carbon left over in a barrel of oil.

The heavier the oil, the higher the carbon content going in; you get much more pet coke coming out; the lighter the oil, the less carbon content in that; you really get very little if any. You don't get any coke out of hydro-skinning [?], a refinery that takes light oil and you need a coking unit in a complex refinery to do this kind of wringing of the oil into solid residue and everything else liquid. That's basically what pet coke is.

Pet coke can basically be used as a replacement for coal. Canada's very far from market, its oil in Alberta is heavy so if you upgrade this oil in Canada and you send it to the US or China or anywhere else as a synthetic oil you have pet coke left over upstream. If you wait and dilute the bitumen and send the oil somewhere else to be refined into a pet coke wherever you sent it the pep coke's this movable feast. It can end up wherever you're dealing with it, it's in the oil to begin with if you're going to process it that way.

Canada handles it very differently than the US does. Canada right now is far from market so when a few of the projects in Canada upgrade the oil up there – and I should say Canada thought this was going to be the way that the industry was moving up there; it's not. They're not going to be upgrading, I don't believe, oil in Canada. It turns out that the pet coke is way too far from market. If you're going to have low-value residuals stuck up in Alberta it's not very economic to get it to replace coal in China and India and elsewhere so right now poor Canada has a lot of pet coke from these few projects that actually upgrade there that produce huge volumes, into the tons [or tonnes] of pet coke and it's far from market, not economic to move it so they've been storing it up there.

But the Canadian regulations say every possible energy resource, anything that could be an energy resource is protected by the Canadian Government to be an energy resource so it's stored up in Canada. It's not producing carbon, greenhouse gas emissions right now but it is slated for future use. It's in storage for combustion, that's the way – until and unless there's a change in regulation or until and unless there's a change in technology to do something else with that, like remove all the impurities that are vast and turn it into water purification carbon, doing something creative with it that isn't for greenhouse gas emissions.

The US is in a very different place. I have a colleague who's going to be releasing a report next month about pet coke from the US that's largely going to China so when the US gets bitumen and we refine it, we get the pet coke by a coast, we have the pet coke that's accessible to markets because it's usually on the Gulf Coast and you can ship it to places that want it. So this pet coke is 10% higher greenhouse gas-emitting than coal. It's very high in different heavy metals than coal is so it creates different problems than plants that burn coal could manage. It's high vanadium and nickel and different things than coal's high in, very high in sulphur, can be six or 7% sulphur. So it's really a very difficult, degraded fuel that the world... it's a waste product that's being burned, that has to be managed.

So then the question was about how to count the displacement, if it's displacing gas or renewables or coal. You get different emissions based on... or if it's just for new generation that wouldn't have happened economically otherwise, just because you have this basically very cheap pet coke to grow your economy on. So there are different variations on the theme and we have right now in phase one an on-off switch for pet coke that David was playing with so you can assume that pet coke is assumed default to be all burned and consumed but you can turn that off and you can see what happens to all of these oil emissions, how the oils re-sort themselves if the pet coke either is stored in perpetuity or we can think of a more creative thing to do with pet coke.

Spain produces a lot of pet coke, Italy, I believe, produces a lot of pet coke. There are parts of Europe that are really pet coke concerns but it's not through and through a bit concern.

DAVID LIVINGSTON: The only thing I'd add is that I was reminded as you talked about the US pet coke export situation that the sad paradox for the US or North American shale revolution is that because the US arguably has a quite antiquated oil governance architecture that includes still an oil export ban even as vast volumes of relatively light sweet fracked oil built up in the United States, that that oil's not coming to world market, but even as fracked shale oil and gas are having a huge impact on the domestic United States and gas of course has played a significant role though not the sole role in the US being on track to meet emission targets that it never thought it was going to make because it's replacing coal in the United States.

The two major energy export items which have seen the greatest growth in the past few years have been coal and petroleum coke and those are the only things that are leaking out of the energy sector and the energy system in transition in the United States and I think that calls attention to opportunities to rationalise the situation not only on economic grounds but also on environmental grounds within TTIP negotiations, within various bilateral discussions between the US and the EU. I think it points to a sad paradox of what's taken place within the [?] conventional energy revolution in North America.

DEBORAH GORDON: One of the things to that question I was going to raise earlier so there are two opportunities to deal with these heavy oils. One is to coke them and to remove the carbon and to reject the carbon and then you have pet coke to deal with. The other one is to hydrogenate them and put a lot – a lot – of hydrogen into them and get more product out of them so a very big challenge for the oil industry and why it's important that we have now this new open-source model prelim for [inaudible 01:21:30] as part of the Oil Climate Index is that how you get hydrogen is going to be a huge greenhouse gas question for the future. There are overlap use of [?] hydrogen and you can go there through coal, you can actually turn pet coke – wring a little bit out. It's basically pure carbon but a lot of the hydrogen comes out of natural gas but you need a lot of energy to dismantle the elements of natural gas back into hydrogen and carbon.

So hydrogen's going to be a very big part of this whole question and doing that. I know Germany spends a lot of time in terms of hydrogen and how to do hydrogen correctly.

JAN CIENSKI: Do you foresee that as the technology changes you'll have to update the model? You mentioned 30, 40, 50 years ago it was a much simpler environment so a lot of what you do now is based on measuring technological change of bringing new things, new approaches that had never been thought of in the past. Do you have a built-in ability to do that as new stuff pops up?

DEBORAH GORDON: Yes. We'll definitely have them in the extraction part of the optioned [?] model because it's codified in California and it has to represent real emissions in California so that will automatically happen and it happens routinely that the optioned model gets updated. The prelim model will go through the same thing and David and I yesterday were talking about... We have a methodology tab that's going to be added to the web tool but actually we'll have a page where we say which oils over time have changed, whether there's new data, that industry's committing to new things on certain fields that will change their emissions or there are updates to what happens in the field. So with that you could track how oils hopefully will race to the top and become better, lower greenhouse gas-emitting because that's the ultimate goal here. If there's that much competition in the oil market you might as well make them compete also on greenhouse gas from that perspective as well.

JAN CIENSKI: We have time for one more question as people are starting to filter out a little bit. Last question? No, great. Thank you very much for taking part in today's panel. Just bringing a Hollywood ending to the theme on technological change, I remember years ago I saw a King Kong

movie in the 70s and they found this mysterious island – it was oil prospectors looking for the island and they found an enormous hydrocarbon deposit which, when they looked more closely at it, one of the engineers said, unfortunately this oil could be oil in a couple of hundred thousand years but at the moment is useless to you. They were left with nothing but a large ape to drive the movie. Now it's obvious that they could turn something very interesting out of that almost oil and this index helps us to capture that.

So thank you very much for presenting that to us and thanks very much for being part and I hope that on 21st April – you're all welcome [?] to Political Europe to see what we can do as well. Thank you.