

Driving Growth

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Greg Dalton: Welcome to Climate One, a conversation about America's energy, economy, and environment. To understand any of them, you have to understand them all. I'm Greg Dalton.

Our program today features a rare public conversation between an oil industry executive and a leading environmentalist. We'll talk about fueling the U.S. economy in the age of climate disruption.

Most Americans recognize the connection between fossil fuels and severe weather, but there's disagreement about how to fix the problem and who will pay the cost. Even fervent advocates for renewable power acknowledged fossil fuels would be a mainstay of the global economy for decades.

Over the next hour, we will discuss building a cleaner and more prosperous economy with our live audience at The Commonwealth Club in San Francisco. We'll also talk about fracking, California's climate plan and a lot more. We're pleased to have with us Fred Krupp, president of the Environmental Defense Fund, one of the country's largest environmental organizations. We're also pleased to be joined by Rhonda Zygocki, executive vice president at Chevron for Policy and Planning. I should note that Chevron is a financial supporter of Climate One and The Commonwealth Club. Please welcome them to Climate One.

Greg Dalton: Thank you both for coming.

Rhonda Zygocki: Thank you.

Greg Dalton: Rhonda Zygocki, let's begin with you. Look at the big picture for the economy and energy. Domestic supply of fuel is up recently. There's more drilling. Demand had been soft partly because of the economy, partly because Americans are buying fewer cars and driving shorter distances. So how do you see the overall picture of energy and the economy right now?

Rhonda Zygocki: Well, thanks, Greg. First of all, it's great to be here. Look forward to my conversation with Fred. And I know from past conversations, we will agree that there are few topics more important than the future of energy, so I look forward to that. And with respect to energy and the economy basically, the link between them is undeniable. Let's think back 150 years. The greatest progress in living standards in recorded history, were made possible because we had abundant, affordable energy. Affordable energy still underpins the way of life we have in America and is paramount to lifting billions out of poverty all around the world.

And today in America, we are undergoing a fundamental shift in our energy landscape that has the potential to keep energy affordable, keep economic growth going, and address our greenhouse gas emissions for years to come. Some have referred to it as an energy renaissance. We've heard this.

But interestingly, this renaissance is not driven by policy, regulation, incentives, subsidies, mandates. This renaissance is driven by innovation and this rock, shale.

To us in the drilling industry, shale was more of a nuisance than it was a gem for many years. It's really tough to drill through and it's not very productive, but America is blessed with this rock and it wasn't until we combined two technologies: horizontal drilling and hydraulic fracturing that we've been doing for 60 years in the industry, over a million wells, that we've been able to unleash the greatest energy stores in decades. And the impact has been remarkable. In less than 10 years, we

have reversed 20 years of domestic production decline in the country. We have created 1.7 million jobs already with the potential to create a million more before the decade is done. We have seen natural gas prices and crude oil imports at 15-year lows.

We're seeing resurgence in U.S. manufacturing. We are replacing coal with natural gas. And yes, even some are suggesting America energy independence is within sight. It's no wonder many countries around the world are looking to emulate our success, and it couldn't have come at a better time in our country because energy development has been a wonderful catalyst for economic growth of late. And the size of what we're talking about will bring multiple benefits that will ripple through our economy for years to come. This resource is so massive it will attract trillions of investment. It will create millions of jobs outside of our industry into manufacturing supply chains, services, everything from bakers to builders to fabricators. We are already seeing billions of dollars enter government revenues that are making their way into our schools, our health care, and our R&D.

And of course, as the cleanest burning fossil fuel, natural gas in combination with the progress we're making in renewables and efficiency gives us greater potential than we've had before for more cost-effective ways to address greenhouse gas. Now, this renaissance, Greg, has not been without controversy. The environmental and safety aspects of shale development have really been in the spotlight, and I know we're going to cover that tonight, and we should. And we are partnering actually with EDF and others to understand this more and to recommend better practices. I look forward to sharing what we do because we are confident we can develop this responsibly. We have to get this right. We are sitting on 100 years of production with the power to add positive benefits to our workers, our environment, our economy, our trade relations, our national security, and our public service. It's not very often that a white swan comes along that can offer the combination of societal benefits at a scale that can be felt across the nation, if not the world, and energy development from shale is that type of opportunity.

Clearly, our energy conversation has changed from one of gas imports to exports, peak oil and resource scarcity to energy abundance and opportunity. How we in the nation take advantage of this opportunity to benefit America is the choice before us. It will take a commitment to responsible development by companies like Chevron and others in our industry. It will take strong regulation and the enforcement of that regulation by the states, and it's going to take community trust and support. But we know, if we work together, we can make this happen for the country. Thank you.

Greg Dalton: Fred Krupp, your response is natural gas a blessing for America. It certainly been a game changer, is it also a blessing?

Fred Krupp: Well, Greg, first of all, it's a pleasure to be here with you and with Rhonda. And it's a pleasure to be back in the state of California. Actually, it's my first visit to the state of California since you all have made history. The first of this year, the California Cap-and-Trade law, the Global Warming Act went into effect. It's been a long time coming. The rulemaking process took six years to develop and yet, you know, now, we have it and we have it in a way that's quite remarkable.

California leads the nation in energy innovation. California also leads the nation in environmental stewardship and despite attempts in 2010 to rip the heart out of this law, the proposition that was put on the ballots. Sixty-one percent of Californians voted to keep AB 32 in place because Californians are smart and they understand the reason you have more clean tech innovation here than anywhere else in the country is because this law is on the books and it's creating incentives for clean technologies, cleaner fuels so congratulations.

If you happen to be in this audience or listening and you're a Californian, you are doing the right thing. Onto shale gas, you know, there's no question that shale gas represents a big economic

opportunity for this country and has created a lot of jobs. There's also no question if you visit the shale gas fields as I have, that there have been more than a few instances where people who live around these operations have been harmed. I remember going to Washington County, Pennsylvania about 30 minutes south of Pittsburgh, and having a woman tell me and the others who were on Secretary Chu's panel, about the fact that she had had to abandon her family farm. Her son was living in friends to continue to be able to go to school, and she was living out of her car because of the noxious fumes had made her and her kid sick.

There are so many operators that even if the best 40 are doing everything perfectly, there are still another couple of thousand because it's such a fragmented operation. So while the economic benefits are obvious, I guess Greg, the environmental implications of not doing this right, in some cases, are equally obvious if you spend the time to look. And the situation has led to controversy largely, and this is something in our report that we pointed out, because for too long too many in industry said, "There aren't any chemicals escaping from the fractures."

And while that is largely true, there had been thousands of cases of the chemicals going into groundwater because of surface spills and because the well casings lack integrity. In some cases, companies haven't even tested whether the cement is well formed. So we need to do three things. We need to, one, get the rules right in order to protect those who live nearby from, not only water contamination, but the air pollution, the community impacts. Two, we need to guard against the fugitive emissions of natural gas, mostly methane, which turns out to be an incredibly potent greenhouse gas, many times more potent than carbon dioxide. So even small amounts of methane leaking accelerate global warming tremendously, especially within the next 20 years when we most need help keeping the temperature rise down.

And the third thing I would say is we need to make sure at this moment, when the nation's utilities are deciding what to do with their power plants, and EPA has put into place regulations that require them to be cleaned up or closed down. And even more than the activism of the environmental community or more than these EPA rules because natural gas has changed the market dynamics so a lot of plants, aside from the rules and the activism, are being either temporarily shut off or permanently shut off.

At this pivotal moment, we need to do all we can to accelerate the deployment of truly clean energy, solar renewables, geothermal and energy efficiency that this country has a lot more of, and that Chevron actually has a business advancing energy efficiency. If we do all that, get the rules right to protect the locals, clamp down on fugitive emissions so we do harvest a climate benefit from switching from coal to natural gas, and prevent the lock-in of new natural gas plants by doing a lot of things to promote these other sources of clean energy, then this could end up being not only a good thing for our country economically, but also environmentally.

Greg Dalton: Rhonda Zygocki, your response to that. There's been some risks, there's been some problems, and that rules in capturing the fugitive methane can make this a cleaner source of energy.

Rhonda Zygocki: Yeah. I mean I couldn't agree more but let me kind of explain. You know, there's been a number of issues that are being raised with respect to the development of shale gas. They range from the disclosure of chemicals, people wanting to understand what's in the frac fluid, which is one percent of what we put down a hole during a fracturing job. They're concerned about groundwater contamination. They're concerned about emissions. They're concerned about road noise and road traffic and local impacts.

And one by one on each of these issues, the industry in my view, has stepped up to address them and promote good standards with the states to ensure we can mitigate these risks. Let me just give you a

few examples, groundwater being one. You know, the standard we use, we use eight layers of steel and casing to drill our shale gas wells. For the vertical section of the well, we use air drilling so not even any fluids are going down and we case eight layers between the surface and the groundwater zone.

The fracture takes place almost more than a mile beneath the surface. And so, as Fred said, we designed our fractures so that they do not leave the shale itself. We measure the integrity of that well under construction and throughout its life. We baseline water wells within 3,000 feet of our gas well and periodically test throughout the life as well, to make sure we get a good baseline on where the water is and we could manage that throughout the life cycle. We disclose our chemicals on a site called "FracFocus." We have 1,700 wells already registered there.

So I think one by one, whether it's chemicals, groundwater, well integrity, we're addressing those with standards. We are urging. The industry has come up with high standards. We are urging other operators to adopt them. We are working with the states to adopt them. We are working with the states to make sure they conduct peer reviews amongst the states so they can see what other states are doing. And on the issue of fugitive emissions, that EDF and Chevron and other companies and academic institutions are looking at, the issue there is we don't have a good grasp on the measurement.

So we've all got together as a concerned environmental community, a concerned industry and a concerned academic community to try to assess this with good measurement, get our arms around it, and then you should look to the industry to say, "Now that we understand it, what is technically and economically feasible, that we can put into a standard." So I think we've recognized the concerns, addressed them kind of issue by issue with facts, data and good engineering practice, and I think urging the states to adopt. Now, on states adopting, we're seeing -- they have been regulating hydraulic fracturing for many decades across the country.

Greg Dalton: Are they doing a good job at it?

Rhonda Zygoeki: Well, I think what we can say is, in the last 18 months, they're doing a much better job in terms of they are raising standards, tightening the regulation, you know, standards for well construction, standards for setbacks.

They're looking at more fines. They're increasing enforcements. So we're seeing a continuous improvement amongst many of the states to address these issues that they're responding to their constituents and their public so it's a continuous improvement.

Greg Dalton: Fred Krupp has Pennsylvania and some other states have been doing a good job policing the fracking that's been going on?

Fred Krupp: No. I think they are doing a better job, on that Rhonda and I agree, but I don't think we can yet say, by and large, a good job. Let me give you an example but first, you know, I do want to thank Rhonda and Chevron, they are leading on the methane issue. They are part of this nine company consortium with a lot of universities to go out in the field. Chevron has given us access, given University of Texas access to its sites. And so, you know, that is real cooperation. And on that and other issues Chevron and several other companies really exhibit the proactive stance that Rhonda and Chevron should be applauded for because it's a good thing.

Unfortunately, the industry is very fragmented. There are 40 companies that make up 50 percent of U.S. onshore production. To get to 75 percent, it's 300 companies. To get to 100 percent, it's well over a thousand. The last I saw over 2,000. So even if you have the top 40 companies doing

everything exactly right, it doesn't give us universal protection, which is why as Rhonda has pointed out, we need the states doing a good job. Now, the jury is out in my mind as to whether the states will get there.

Three quick examples, one, in Colorado, EDF and Shell, initially a couple of other oil companies, agreed on the sort of baseline testing that should be done before drilling happens. The trade association for the larger groups, you know, went to the Governor Hickenlooper's office and said, "This is, you know, going to be too costly, too expensively, let's get rid of it." Unfortunately, the regulations that came out, axed the idea of scientifically sound testing at the baseline. And the disclosure issue, many states have now within the last two years quickly put disclosure rules in place. That is good. But too many companies, according to the data that's beginning to come out, are claiming trade secret for hundreds of chemicals when before the rule was put in place, they said, "We'll, only claim it for a handful of chemicals."

So the trade secret provisions are being abused and they now need to -- we need to go back and tighten them. We argued that they should be tightened before they were put in place. You know, now, I think there's the evidence that will allow us to finally prevail. And third, let's take a state like Ohio, where Governor Kasich, a Republican conservative, a former member of Congress is now governor. He proposed disclosure not just to the chemicals going down the hole but what we call "spud to plug." So from the very beginning of drilling to the end of the operation of the well, there would be complete disclosures to what's going on as opposed to just during the limited drilling phase. The trade association for the oil companies in Ohio said this was too much and the governor's own proposal, you know, didn't pass the Ohio state legislature.

So I think the cooperation we are getting from some companies is great, it's just that when you have so many companies and the trade associations tend to represent the lowest common denominator, you know, we're still in a period where in my mind, Greg, the jury is out as to whether the regulations are going to be strong ones and whether we're going to see the compliance and enforcement of stiff penalties that we need to protect folks.

Greg Dalton: Fred Krupp is president of the Environmental Defense Fund. Our other guest today at Climate One is Rhonda Zygocki, executive vice president of Chevron. I'm Greg Dalton. All right. Rhonda, do you acknowledge that you can't control all the risks of the industry? Chevron is just one company that there's risk for. The little guys, the mom-and-pop players out there can create risk that affects the majors. You can do everything right, but there's still risks in the system that Fred has been talking about.

Rhonda Zygocki: Well, I think for a big company, I mean we stand on our reputation and our track record but we also stand with the industry as well. So it is in the best interest of us to continue to encourage all actors in the industry to adopt these standards and that's exactly what we are doing. You know, nothing happens instantaneously and overnight but we are in a mode of continuous improvement and we see -- you know, we see the states moving very quickly on this relative to, you know, where the issue has been and the progress we're making.

Let me just make one comment on trade secrets. We've been pushing our contractors too, really to kind of liberalize the information they're disclosing on trade secrets, and we have worked, and we have made significant progress. We're not 100 percent there yet. We made significant progress over in a very short time to get them to disclose more and more all the time. And then for our part, we've reduced the number of chemicals kind of classified as hazardous and meeting Material Data Safety Sheets, for example, 77 percent just over the last two years from 37 to 7.

And so bit by bit, we're working these issues and it truly feels like we're in a continuous

improvement mode and that's a good thing because whether we're talking about hydraulic fracturing regulations or air emissions from tailpipes. The industry is constantly in a continuous improvement mode and really on hydraulic fracturing is in that mode as well.

Greg Dalton: One more question on fracking then we'll move on to some other topics. Is it possible that there will be waterless fracking someday? Could there be a technological breakthrough? One recent announcement was Halliburton recently said that they have fracking fluid that doesn't have toxic chemicals in it.

Rhonda Zygocki: Right.

Greg Dalton: Which would address a lot of these issues --

Rhonda Zygocki: Right.

Greg Dalton: -- if it comes in at a cost that the industry is willing to pay.

Rhonda Zygocki: Well, I think we're always looking at new technology to address the issues that are of concern, and whether that's substituting kind of hazardous chemicals for non-hazardous, whether that's looking at different ways to frac wells. Yes, the answer is we're always going to be investigating improvements in technology that can make our work safer, less risky and more cost-effective. That's kind of the norm in the industry.

Just to give you one example. We commit to 100 percent water recycling in our frac. So everything that flows back, we treat and we use it on the next well. In doing so, we developed a tank system that, these are kind of a million gallon tanks a piece, and just using the tank system and the recycling, we can shrink the footprint we're using even on the surface of the land from 20 acres to 10 acres. So I mean a very short order we're addressing all of these issues and technology is helping us get there.

Greg Dalton: Fred Krupp is technology enough or is policy absolutely necessary? The industry -- can they get there alone voluntarily and with technology or does the government has to play a role here?

Fred Krupp: Well, that's a great example Rhonda just gave. You know, the sites I visited recently in Pennsylvania, the waste comes out of the well, millions of gallons, and it's put in a pond. There are wires on top of the pond to try to keep the birds from landing in it.

Sometimes when it comes up, it's got radionuclides, if that's what's been down the well. So it's not only what's been added to the well and the water intentionally, it's also what was in the geology that comes out. And, you know, Rhonda has talked about a much better system where things are enclosed in tanks and not left in open pits, but I don't know that we're going to get there in a place like Pennsylvania or and a lot of other places until it's required of companies to get there. So Chevron --

Greg Dalton: Do you think federal action would be required? Federal policy is where this has to happen?

Fred Krupp: We need action at the state level, at the local level, and at the federal level. Right now, most of the action, because of the politics of it, most of the progress that's being made is at the state level. I happen to believe that localities, one of the great ways to make progress here is that localities should have the authority to regulate as they have other industrial activities, and even the authority to say, you know, "This is a place where we're not going to allow this activity to go

forward." I think making sure the localities have that level of control would be a great safeguard to make sure that the companies were truly wanted there by the locality. So I think there's a role for all three levels of government and there's certainly room for improvement by all three.

Greg Dalton: Let's move on talk about science and some of the other risks. Rhonda, the Chevron website says that, "Some international scientists are saying that warming is unequivocal and human activity is most likely the cause." So I just want to -- it seems like the company accepts that. Fatih Birol who is the chief economist of the International Energy Agency said recently and told Reuters last year that, "Current projections for greenhouse gases are on track to reach 11 degrees of Fahrenheit warming by mid century, 11 degrees."

We've had about one degree so far, so that's 10 more degrees in the next 40 years. What does that look like for Chevron, for the economy the 11 degrees of warming? This is the chief economist at the foremost world's energy authority. Talk to me about that.

Rhonda Zygocki: Well, Greg, I'm not a climate scientist so I'm not even qualified to address what 11 degrees means for kind of Chevron on the economy. What I can tell you is that, we share the concerns with the government and public about climate change. We think prudent action is the right thing to do and you have to look to a company like Chevron to say, "Okay. So how can we contribute to this issue?" For our part, we are spending billions of dollars to reduce the flares, mostly in our Sub-Saharan African operations and Fred talked about methane being one of the most potent.

Greg Dalton: And burning of excess --

Rhonda Zygocki: Burning of natural gas that comes up with the oil that can't make its way to a market because there really are no domestic markets that are that mature in the African area where we produce it. So we're spending billions to either re-inject, convert that gas to diesel or get it into LNG, and ship it to foreign markets. We are a participant in two of the largest carbon sequestration projects being developed in the industry today, one with our Gorgon LNG project in Australia and one in an oil sands operation with Shell. So we're the largest looking at the sequestration arena.

As Fred mentioned, we have a company dedicated to energy services and energy efficiency and renewables installation. We're doing demonstration projects for solar-to-steam right here in San Joaquin Valley in California. We have researched over 100 feed stocks and 50 conversion technologies, trying to crack the code in cellulosic biofuel. So just to name a few and we are one of the largest producers of renewable energy particularly for an international oil company by the virtue of our geothermal operations in the Asia Pacific region.

And so when you think how can we contribute to the issue, I think we look at how are we finding the engineering solutions that can be done cost effectively at scale? And I would say at the last 10 years, Chevron has looked at everything from renewables technology to sequestration technology to spending billions to put out flares, to try to get our arms around what can be done, what can be scaled, what can compete in the market, and that's where you should look for our contribution.

Greg Dalton: And when you look to the future, do you have a shadow price on carbon? Some oil companies have \$35 of price.

Rhonda Zygocki: Yes.

Greg Dalton: ConocoPhillips, I think, is \$35. Do you sort of plan in a price on carbon when you look to the people?

Rhonda Zygocki: Absolutely. We look at the markets around the world that are -- and we operate in a number of various areas that we're operating under carbon markets. The European Union being one, Australia being another, parts of Canada being another. So what we do for our projects, all of our capital projects kind of include the cost of carbon in them depending on the jurisdiction. So yes, we do account for our estimates of how carbon markets will evolve and looking at our capital expenditures.

Greg Dalton: And a report came out recently that the average among industrialized economies is about \$70 per, I guess, per ton of carbon. The U.S. price is about seven. This was from the OECD and the New York Times of last week. So the question is, Fred Krupp, is the price on carbon high enough for the United States compared to other developed economies? I think Mexico is the only company -- country that had a lower price on carbon than the United States.

Fred Krupp: Well, no.

Rhonda Zygocki: No?

Fred Krupp: We need to put a price on carbon and greenhouse gas pollution. We need to put caps in place so that we are effectively reducing emissions. The Environmental Defense Fund, you know, is open-minded about what policies will work, caps, cap-in-trade, tax, whatever, the test is does it get emissions down? And there's got to be urgency.

You quote Fatih Birol, talking about the potential temperature rise if we continue on the high emission scenario. Unfortunately we've been on the high emission scenario for, you know, the last two decades. But we are now seeing the sort of extreme weather events that are waking people up. Tragically in the United States eleven events in 2012 with effects of over a billion dollars. I was affected in my home by Sandy, not nearly in a way that many people were who lost their homes or had severe damage. I was just out of power for eight days.

Greg Dalton: Your office is in the 20s in Lower Manhattan.

Fred Krupp: My office was out of power, no one was allowed into the building for a week. But, you know, we got off easy compared to the real victims. Which, you know, maybe because of that in part we're emerging from two years of climate silence in the United States, where no one would talk about this. We have the President of the United States in his inaugural address saying it very well if we fail to address climate change, we will betray our children and future generations. And beyond that, in Davos a couple weeks ago, we had the head of the International Monetary Fund Christine Lagarde say if we don't solve climate change future generations will be roasted, toasted, grilled and fried. You know, if I said that I don't think it would even be picked up in the press.

Greg Dalton: But you don't have the French accent that she has, the panache --

Fred Krupp: And she sits at the center of our international financial community that's her assessment. She hadn't talked about climate change for a while before that.

But not -- it was not only her, it was Doctor Jim Kim. The president of the World Bank who, when asked to address the Davos crowd, spent seven of his ten minutes talking about the fact that the most impoverishing force on the face of the planet right now is climate change and extreme weather. And the World Bank, whose mission is to prevent and ameliorate poverty has got to get more involved. So when you have the head of the IMF, the President of the World Bank, President of the United States talking this way, I think there is hope but we need more than hope, we need action. And while talk is just talk, you know, silence has been very expensive up until now. And through

leadership and talk, the President's got the opportunity now to connect the dots for the American public so that we can get back to a time where it's possible to envision Congress taking the action that this country desperately needs to take. I can't envision that happening in the next year or maybe even the next two years -- Congress acting, but I can imagine the President leading a conversation that prepares the country and Congress to act.

Greg Dalton: Rhonda your response?

Rhonda Zygoeki: Well, Fred has mentioned that the climate change is an extraordinary challenge and it is. Reducing greenhouse gas emissions in the world and finding engineering solutions or policy solutions to that has been a challenge to many nations. I mean, there is a number of a reason why we don't have a global framework in place. And this is a dilemma particularly for the developing nations of the world. How do they balance economic growth, energy security and addressing emissions? It is an extraordinary kind of physical, physical challenge. When we look at climate change from that perspective and we operate in 30 countries around the world with governments that take different points of view on this.

We understand it very well and what they're trying to balance in managing their nation's well-being. And we see really three things for climate change. It's, you know, very, very difficult to, you know, Fred said, you know, not enough price on carbon and I kind of agree because actually, there's only two or three place in the world that have a price on carbon. And I think the European Union's about six euros a ton now and --

Greg Dalton: So would it help to have a higher price in the United States or that applied always?

Rhonda Zygoeki: Well I think what it was going to get it -- it's just a very difficult thing to do. Because the price on carbon means a price on energy means a price on the economy. And I think that's the dilemma that most nations have particularly the emerging economies. So when you look at this situation, there are a couple things to think of. The energy system in the world which is 80 percent carbon based is massive. We move the equivalent of 250/60 million barrels of oil around the world today to power the world whether it's electricity transport and so on and so forth; it's a massive system. It's hard to imagine the scale this is. When you look at taking carbon out of the system, it's going to take massive investment. You need to look at solutions at scale. Let's take solar, solar is one percent of the world's power today. If we multiplied it 700 percent by 2035, it's still going to be 1 percent of the world's power, today it's starting from such a small base. And so I'm not sure that energies like wind and solar can scale up in time in the time frames that we're talking about over the next 20 years. So when you look at solutions at scale, we come down to three leavers that are possible. If we can get to understand the emissions, the potential of natural gas is there, and we really have to explore the potential of that in addressing greenhouse gas emissions are giving us low cost solutions. Energy efficiency is a very much understated opportunity we have. I mean our energy efficiency and transmission, kind of energy from source to kind of power to plug: 50 percent -- 30 percent at best.

And so, the waste we have in just transmission and conversion of energy is extraordinary opportunities that if you can get that right it can be scaled up in extraordinary ways. Fatih Birol will also tell you that in the transportation sector, the most important thing we can do to address greenhouse gas in transportation is not trying to design a new fuel with cellulosic biofuel which is very, very hard. But it's to improve the fuel economy of the passenger vehicle. And in this nation we are doing that. And we do expect the fuel economy of the global fleet to increase about 40 percent over the next 20 years. So I think efficiency has not been tapped as much as it should be. And the third area is really more R&D. It is very -- going to be very difficult and almost not affordable to be able to scale the renewable technology we have today with the cost that it is. And the challenges it

has whether it's lithium-ion batteries, whether it's intermittency in storage of wind, and solar and how much we can push into the grid. We do need new breakthroughs that can be scaled and keep energy affordable. And so when we look to the government, I think they're doing good work in energy efficiency and fuel economy, we're going to explore natural gas, and the government has a huge role to play and continue to push R&D that can create the breakthroughs at scale that we need.

Greg Dalton: On R&D we had John Hofmeister here a few weeks ago. The former President of Shell Oil and he said, "If we cannot get off the internal combustion engine with all the technology available to us, shame on us." So can you see that R&D leading beyond the internal combustion engine?

Rhonda Zygocki: Well it can but let me just tell you the internal combustion engine is not going to go away anytime soon. We just finished a very important study for Secretary Chu -- Energy Secretary Chu called The Future of Transportation Fuels in the US.

It brought -- it's the National Petroleum Council did the study but it is more than the National Petroleum Council that worked on it. Over 300 academics, business leaders from the auto, energy experts in the field, from material science right through the energy efficiency, convened, and for 18 months worked on the question of what's the future transportation in the country and to Secretary Chu's question, how do I get greenhouse gas down 50 percent in my fleet. And so they worked on this study for 18 months. And this group, and getting back to R&D, took over 200 technologies and boiled them down and came to a consensus that there are 12 key technologies that the Federal Government should be funding and doing research on that will create the most breakthrough in transportation into the future. And those 12 technologies cut across different vehicle types. So there was one technology that cut across the entire fleet and it was with light weighting. So new materials that can be put on either in an internal combustion engine car or a plug-in hybrid or an electric vehicle or a natural gas vehicle. Also, efficiency improvements in energy conversion and internal combustion engines was also very important, as was breakthroughs in lithium-ion battery technology on storage technology for hydrogen vehicles, so every vehicle, that was -- that we're looking at for the future we don't know which one is going to win, but we do know that we picked key technologies across that fleet and not knowing which one will emerge.

Greg Dalton: We're gonna go to our audience questions in just a minute, but first I want to touch on California. Fred mentioned California, and California has done a lot, perhaps more than any other state, on addressing climate change and promoting new technologies as well as research and development.

So I'd like to hear you talk about California's system for addressing climate change, is it moving in the right direction? It's not quite aligned with the rest of the country yet. So let's have Fred speak a little further on California moving on a cap-and-trade direction. The rest of the country cap-and-trade is politically poisonous, probably dead. Is that going to work out for California, can they continue to go in a different direction than the rest of the country?

Fred Krupp: Well Greg, I don't think cap-and-trade is happening this year or next in Washington. I think I said that earlier but, actually we have cap-and-trade in, you know, a huge part of the country in the Northeast in addition to California by the power plants. New York's pretty big place, and there are several other states too. So, and by the way, in terms of the rest of the world, you have cap-and-trade not only in the European Union but now in China. In the 12th five year plan, they are putting cap-and-trade in five cities and two provinces that together represent 250 million people living in cap-and-trade regimes, putting a price on carbon and depending on how it goes we'll see what they do in the 13th five year plan. Brazil has put a cap on carbon, and by the way, Brazil has

reduced its emissions more than any other place in the world, thanks to reduction in deforestation. And beyond that, you have South Korea, Australia which is starting with a carbon tax which becomes a cap-and-trade system, New Zealand. So, you know, this -- the idea that the price in carbon is inevitable; there is evidence around the world in some pretty populated places that it's happening, in addition to the most important place in our country where it's happening, which is right here in California. And right here in California, I am more hopeful, maybe than Rhonda, about technologies that are coming.

You know, thanks to the low carbon fuel standard that's being phased in between now and 2020. Already, manufactures of just plain ethanol are changing the way they refine the fuel. So up until now, many refineries of ethanol had been doing it using coal to fire their plants. Thanks to the California standard, they're switching out of coal, and in some cases to natural gas, and in some cases to agricultural waste. So this is, you know, already we are seeing changes in the fuel.

I agree with Rhonda, we absolutely we have to get cars to be as efficient as possible. But I guess I part ways thinking that no progress is possible on the liquid fuels. People are earning credits against this system, now and also electric vehicles will be brought in. California is maybe the center of the whole world on the development of new electric vehicle technology. I do think it's good to have to hear Rhonda calling for government R&D, I'll join that call, I think we need the government investing in basic research. But there ain't nothing like the profit motive to get an entrepreneur's juices going. And we need to have that price on carbon and the California system is, you know, creating a system where there's a tremendous amount of clean tech investment going on. And I'm not going to bet against the entrepreneurs inventing new ways to take carbon out of the system.

Last point, Rhonda mentioned natural gas, and we have to get the emissions down. I agree, EDF having done the analysis, sees natural gas as better than the alternatives under lots of scenarios. If we can get the total amount of natural gas that we pull out of the ground, we can get the fugitive emissions from all parts of the natural gas infrastructure down below one percent. That's what the math shows and we look forward to more industry and governments adapting that as a common platform in the year ahead.

Greg Dalton: If you just joined us, our guests today at Climate One are Fred Krupp, President of Environmental Defense Fund and Rhonda Zygocki, Executive Vice President policy and planning at Chevron. We're going to go to audience questions but first Rhonda, on those couple of points, California's cap-and-trade system and the low carbon fuel standard which calls for a 10 percent reduction, is that something that Chevron supports in California?

Rhonda Zygocki: Well I am going to -- this is probably where -- we agree on so much tonight where it's just remarkable but here's we might just part -- part philosophy. When the AB 32 was passed into law, Fred is right, six years it's taken to do the rule making, complicated law --

Greg Dalton: It's California's main climate law.

Rhonda Zygocki: Correct. Yes, thank you AB 32 yes, Assembly Bill 32. We committed to the state that we're going to help you make this work. We brought our top scientists, fuel experts, refiners. We worked with CARB, rolled up our sleeves, how can we make this low carbon fuel standard work. It was at a time when we had great promise for cellulosic biofuel, fuel that would be available in the market, you know, six years out and we've reached this point and it is not available. And here we are going into a compliance period. Like I've mentioned earlier we've looked at a 100 feed stocks, 50 conversion technologies, work to shape this law the best we can, and we have not come up with a solution to be able to comply with this.

In the near term, the best we can do and that can achieve compliance is actually with Brazilian sugarcane ethanol. So what we'll have to do as fuel suppliers in the state is bring in \$50 billion of sugarcane, which is ethanol from Brazil, to comply with the low carbon fuel standard. That's pretty much about everything they produced down there. So we're probably now going to have to shift Midwestern corn ethanol back into Brazil. So we've created a law that in its timing of implementation and its design, we believe is not workable, and we believe CARB does need to go back --

Greg Dalton: That's the air regulator in California.

Rhonda Zygocki: --the air resource board to go back and take a look at this. We have tried for years to really help California meet this objective. And it's really, really, tough. And we believe the consumers of California who will probably be paying for this Brazilian ethanol really don't understand the cost on a gallon for the small benefit we're going to get. So we have concerns, you know, working with CARB to try to sort them out but maybe a difference of opinion on the breakthroughs we've been able to have over the last six years to get ready for compliance with this law.

Greg Dalton: And on cap-and-trade quickly then we'll go to audience. But there's some litigation on the main cap-and-trade program, where are you on that? Aside from the low carbon fuel standard, the cap-and-trade program that's speaking from the point--

Rhonda Zygocki: Oh I think you might be referring to -- I don't know it for sure, but you could be referring to the kind of the challenge of auctioning permits in the cap-and-trade. Is that --

Greg Dalton: Perhaps, I'm not sure, yeah, there's some people fighting all different ways so yeah --

Rhonda Zygocki: Oh okay. Well, on that one in particular I think the position of the industry is that you don't need to auction the permits to achieve compliance and it just adds cost to the --

Greg Dalton: Which should be given away okay.

Rhonda Zygocki: Correct.

Greg Dalton: Let's -- welcome to Climate One yes let's have our first audience question.

Audience: Sure. My name is Michael Pierce. Ms. Zygocki, thank you for coming this evening. I believe there's one thing that you and other executives of companies in frack -- involving fracking can do to make members of the public believe more about your claims about safety.

If you and personally and the executives of all the 2000 companies involved in fracking in American Petroleum Council all committed to have yourself and your families, your kids and grandchildren, spend at least a month living next to an open pit fracking lake each year, then people might believe your claim. So would you personally commit to living next to an open pit fracking pond for one month a year and maybe have your executives at Chevron do that as well.

Rhonda Zygocki: Well, thank you for your question. I can tell you that I grew up in the oil patch. I started as an engineer drilling wells. I spent many a day and months in the field working in these operations.

Greg Dalton: I want to mention that we welcome your participation with one, one part question. And if you need help keeping it simple and brief, I'm here to help you with that.

[Laughter]

And we have 14 minutes left, we're going to try to get through as many questions and as many answers as possible, so let's move this along. Yes sir, welcome to Climate One.

Audience: Hi, my name is Peter Jesella and this is directed to Fred and the EDF. I was wondering if you could have internal but transparent debate over leveraging the selective service program into a debate on national policy for male registered youth between 18 and 19. This is something I've been interested in for 30 years, shared it with Rhonda a year ago, got a very nice letter from --

Greg Dalton: Thank you I think --

Audience: --James Davis President of the Chevron Energy Solution saying they have a different approach. And I would wonder if EDF would be willing to embrace the debate over this.

Fred Krupp: I look forward to seeing your proposal.

Greg Dalton: Let's have our next question. If you're just joining us, we're talking with Fred Krupp from Environmental Defense and Rhonda Zygocki from Chevron, hi.

Audience: Good evening. I'm Dave Massen with Citizens Climate Lobby.

We're proposing a steadily rising fee on the carbon content of fossil fuel with all money collected return to citizens. We are running out of time to start bringing down emissions and we would like to see this pass in Congress this year. It's capable of bipartisan support. Will your organizations both support us in this legislation?

Greg Dalton: Fred Krupp.

Fred Krupp: I think that's, you know, very interesting idea. Carbon tax, cap-and-trade, cap-and-dividend, we've got to look at all these things. I would like to think what you said is true that it can pass in Congress this year. I haven't heard a single Republican member of Congress so far embrace anything like what you've proposed. But I --

Greg Dalton: Lots of Republicans outside the Congress embrace this.

Fred Krupp: Outside but not in Congress. So I hope you can inspire them and if, you know, we definitely want to get carbon down using whatever policy instrument.

Greg Dalton: Let's have our next question, welcome.

Audience: All right, Gary Malazian. Has anybody on stage seen the documentary Switch?

Greg Dalton: Heard about it.

Rhonda Zygocki: No.

Audience: I had the good fortune of seeing it last Wednesday night at SPUR, San Francisco Planning and Urban Research Association. I suggest you have a look at it. It brings everything you're talking about to scale. And all the -- if you put all the sustainable energy, paradigms together, they are growing. Oil and coal are diminishing, that line will cross in 2064 by then the planet will have cooked. The best way is for the American people to realize that their paradigm for living has to change. How do you suggest we get that message across?

Greg Dalton: Fred Krupp. Some people view sort of addressing climate change as a war on their lifestyle. Is that -- you know, it involves sacrifice or change in consumption patterns et cetera.

Fred Krupp: I think there are enormous reductions of emissions that we can get doing things the way we do now in large measure but there are going to have to be substantial changes, we are seeing radical changes. Just last month, miles per gallon in passenger -- new passenger cars being sold in the United States went up from December to January by just about half -- half a gallon, half a mile per gallon. That's a pretty significant change, thanks to the president's leadership and a bunch of companies coming together in the auto industry at the beginning of his first term. Now we need, you know, to see more of that. You know one thing in terms of the grid and renewables and intermittency, that I also want to point out, Greg, is that this intermittency thing, our grid now that operates the way Thomas Edison, you know, put it in place. And that means you have to have voltage that's being used equal to what's being produced. And so what's being used goes up and down and then we hurry up to get the power plants to go up and down. Aha, it turns out now, through technologies that are common in the internet, we not only can have power plant supply go up and down, but we can help influence demand to go up and down. Buildings can create ice at night to cool during the day. They can shave peak loads, when the grid needs it. My refrigerator can be told defrost at 3:00 a.m. instead of 3:00 p.m. You can get home from work and the car doesn't need to charge -- I mean electric car at 5:00 p.m. it can charge at 2:00 a.m. (0:54:00)

We need to have a much more investment in the grid to be able to integrate a lot more renewables. And thankfully, California is leading the way on that given your PUC here.

Rhonda Zygocki: I mean if I could just add. I couldn't agree more in terms of the -- and it gets into the energy efficiency and conservation aspect of where -- these are opportunities at scale. I mean I think 50 to 1 if we turn off our light switch it saves 50 times that up the chain. And therefore, a conversation in America about the value of energy efficiency, what we can do, which I think not even changing our lifestyle, but just understanding the waste we don't even know we have in our daily lives, and how technology will continue to help us manage that in the future, I think is a wonderful opportunity.

Greg Dalton: Let's have our next audience question. Welcome to Climate One.

Audience: Since I live here in San Francisco, I feel like yes we have our political leaders who, and representatives who are, you know, doing their best to work on these issues. And so I feel helpless to help the rest of the country politically or is there something people in the place like this can do on that.

Greg Dalton: Fred Krupp, what can individuals do?

Fred Krupp: You know, I think California is modeling for not only the nation but the world, the whole world right now is watching AB 32, including the low carbon fuel standard that Rhonda and I disagree about. But I think we can make that work, by the way Rhonda, I don't think it's realistic that Brazil is going to be exporting ethanol the economic scenarios that I've looked at --

Rhonda Zygocki: That's right.

Fred Krupp: --don't show, you know, any scenario where that happens. CARB predicts that at very low cost at the world carbon fuel standard. So, you know, making AB 32 work, making the California Global Warming Act work, all working cooperatively, I think right now, if you live in California, you will be creating a shining city on the hill to paraphrase what someone else said.

Greg Dalton: Let's our next audience question for Fred Krupp and Rhonda Zygocki.

Audience: Hi there, my name is Dominic I'm a graduate student in energy engineering at UC Berkeley and I have stated -- I want to get both of your opinions on its relationship between renewables and energy efficiency. Mentioned this is the main point in kind of sustainable management fracking. And I'd like to get your opinion on whether there is a trade off, if it's one or the other. If we take a look and go in concert with each other or if there's kind of a decision to make between both of them, I'll be curious to know whether Chevron's investments in renewables, how they compare with that with hydraulic fracturing, if they decrease since they acquired Atlas Energy and other things like that. They can both increase at the same time.

Greg Dalton: So fracking and renewables.

Rhonda Zygocki: Okay, so the question was how do you compare the two or just --

Greg Dalton: Or is there a trade off, I mean is it or or is it and --

Rhonda Zygocki: No, no.

Greg Dalton: --some people think that they complement each other.

Rhonda Zygocki: No, it's an and. We need all the energy that the world can develop economically and commercially. We need it all. And so these aren't energy and technologies that should be competing with each other. These are technologies that should work together to supply the world's energy. The most important thing about this is whatever technology we developed in energy, it needs to be able to compete in the marketplace for energy that people can afford to keep economies going. So that's, you know, there's no competition in my mind.

Greg Dalton: You know, just one more thing and then we'll get to Fred. Chevron Energy Solutions is part of the sort of --

Rhonda Zygocki: Oh yes.

Greg Dalton: The clean energy part of Chevron. But it doesn't get a lot of capital right?

Rhonda Zygocki: Right. Yeah, if you ask the question how much we spend. We spend about \$2 billion in renewables over a three year period. And that's kind of -- and that covers everything from our biofuels to our geothermal, to our energy efficiency solutions and services so.

Greg Dalton: Fred Krupp and then we'll get -- Fred.

Fred Krupp: Well, you know, natural gas the boon we have can be either a good think to help integrate renewables into the system and help offset some of the intermittency issues that are going to be there even after we create a smart grid or we can have a glut of natural gas that can be created in way that we use the environment and the people whoever it harms. So we've got to do it right. But one thing for sure is its part of the reality of living in this country right now. We are doing a lot of fracking, 90 percent of all the new wells are fracked. We can't just pretend that we can wish it away because pretending we're going to wish it away leaves people living next to it that aren't protected by strong rules. We have to roll up our sleeves, do the hard work to get the rules that protect the people that are going to live next to these sites. And make sure we get the climate benefits and make sure that natural gas is integrated in a way that doesn't displace the increase capacity we need in clean energy.

Greg Dalton: Let's have our next audience question for Fred Krupp and Rhonda Zygocki.

Audience: Yes, Marissa Saretsky from Ernst and Young. My question is regarding energy efficiency, you were mentioning that that is the main -- a main topic for Chevron. And I guess my question is around not how much Chevron is investing in energy efficiency but also the information they disclose on its own energy efficiency and reporting on CO2 emissions and energy consumption from year to year. And I was wondering, I know that you do publish this kind of information, but at this time, it doesn't seem that there are quantitative objectives outlining I guess main goals by 2020, 2030 in terms of energy consumption and CO2 emissions. And I was wondering to have, you know, if you could give me a perspective on that knowing that a lot of international oil and gas companies are doing so.

Rhonda Zygocki: Thank you. We maintain -- we've been working energy efficiency in our operations for the last 17 years.

And since 1992, we've reduced our energy kind of intensity in our business is about 30 percent. And so that saving obviously a lot of emissions and billions of dollars in operating cost and so it's been a very economic proposition for the company. In terms of our goals in the future, I mentioned earlier in the discussion about that we're spending billions of dollars to put out flares in our operations, international operations. That is probably one of the most substantial things that we can do. In part of -- in our part, in our operations with respect to greenhouse gas, and we have a long term kind of decadal plan to do that. We've already taken down those emissions 43 percent and then our biggest operations are going to get down another, get to 68 percent reduction in the next few years. I mean these projects, to bring down that amount of flaring are multiple billions of dollars and decade long projects in their own right. And so there are energy developments in their own standing. And so those would be the most significant goals we have to eliminate flaring and venting in those massive operations. Along those lines our operating standard for anything new built is to minimize flaring and venting everywhere we do this. So it's become an operating standard in the company.

Fred Krupp: Now energy efficiency, Greg, is just such an enormous opportunity for people to get pay back. Doug Shorenstein, of Shorenstein's Realty based here in San Francisco, told me the other day, you know, he's investing and relighting, remapping some parking lots that have a six month payback. And you imagine the return on that but even if with the lower price of electricity now because of the natural gas, even if it's a five year payback Doug said to me, "You know, five year payback that's 20 percent a year. And the last time I looked at my bank account I wasn't getting 20 percent annual interest rate."

So, you know, this is an opportunity for the president to lead asking people to do what's in their own self-interest, invest in things that have a payback of five years or less, and this is the scenario that I think we should be able to get great bipartisan cooperation to even heighten the incentives because it makes America leaner and stronger and more competitive while reducing carbon pollution.

[Applause]

Greg Dalton: Let's have our --

Rhonda Zygocki: Yeah. And Fred is right, of all the options we have to address this, energy efficiency is the most cost effective with the shortest payback above all the options and I think and easier to get to scale once you get these solutions.

Greg Dalton: What have you done in your homes on energy efficiency, each of you?

Fred Krupp: I have put insulation in the roof, like 12 or 14 inches in the basement, which turns out to be the best investment of all. I have put new windows in the house to reduce energy. My bill -- oil bill in this case has, you know, plummeted.

Greg Dalton: Rhonda.

Rhonda Zygocki: Oh well, big thing probably is solar heating for our backyard swimming pool which is I mean a great saver. And I think the programmable thermostat, so we can program in that it comes on automatic and keeps the heat down when we're not there, air con come down when we're not there. So all the gadgets that PG&E can provide well.

Greg Dalton: And so -- last question and we'll wrap this up quickly. Yes sir.

Audience: Rhonda, you mentioned that test wells around your fracking sites?

Rhonda Zygocki: Yes.

Audience: Let's just say that from some of those test wells you learn that there are toxics going into the water table. At that point, what can you do -- can you remove the toxins from the water table? Is there anything you can do at a fracking site to undo the damage you see that has been done?

Rhonda Zygocki: Yeah, well first of all, first thing is prevention and we put a multiple safeguards prevent that from even happening. So that's first thing, but if we ever had information to suggest that we had any kind of damage to ground water, first of all we would try to identify the source: is it coming from a well, is it coming from a surface where did it come from. We can isolate that -- first of all, we would make sure that nobody is exposed to that water, if it's not up to a health standard for sure. We would then probably drill some monitoring wells around that to try delineate the extent of contamination, and see how we could remediate it.

Greg Dalton: Our thanks. We have to end it there, we've been listening to conversation about powering America's future with Fred Krupp, President of the Environmental Defense Fund and Rhonda Zygocki, Executive Vice President at Chevron. I'm Greg Dalton, you can listen to podcast of this another Climate One programs in the iTunes store. And also follow our Twitter handle at @climateone and see photos of this event on Facebook. Thanks for coming to Climate One today.

[Applause]