

# Petropoly

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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.

And today, we're looking at global markets for oil and other forms of energy. Many energy experts say OPEC is a dysfunctional band on the way down, while the U.S. is a rising star supplier.

Increased domestic drilling could drive the United States past Saudi Arabia as the world's largest petroleum producer by 2020 -- just seven years.

Over the next hour, we'll discuss the economics and politics of petroleum and the changes -- chances of cleaner fuels breaking into the market. We'll also talk on the production of electricity, which is more localized and often conflated with oil markets. Joining us with our live audience at the Commonwealth Club, we're pleased to have three experts. Eyal Aronoff is co-founder of the Fuel Freedom Foundation, a Washington D.C. think-tank. Kate Gordon is director of Energy and Climate Programs at Next Generation, a think-tank here in the Bay Area, and also a commentator with the *Wall Street Journal* online. Gal Luft is co-director of the Institute for the Analysis of Global Security and co-author of the book *Petropoly: The Collapse of America's Energy Security Paradigm*.

Please welcome them to Climate One.

[Applause]

**Greg Dalton:** Thank you all for coming. Uh, I'd like to begin with a brief story of how you came to this area of energy markets and petroleum. Just tell us a little bit how you kind of got in the -- I won't say you got any oil business but, Gal Luft, tell us how you came to these issues.

**Gal Luft:** Well, I -- I was in the National Security counter-terrorism space. Still in the days pre-9/11 when people like me used to go around and say "Bad things are going to happen on the terrorism front," and people would say "Oh, that's very interesting," and did nothing about it. And when 9/11 happened, everybody got it. I've -- I asked myself "What am I going to do now because everybody is a terrorism expert?" So I [Laughter] but at the same time, I --

**Greg Dalton:** New entrants in the competitive market.

**Gal Luft:** Exactly. So I -- but at the same time, it dawned on me that much of what is happening to America, much of what happened in -- on 9/11, you know, when you hear bin Laden says, "We attacked America because you guys are in the land of Mohammed and you support regimes that we think are not Islamic enough," and you know, I began to connect the dots. And that brought me to think about this issue, knowing little about what can be done. And I said, you know, "Maybe there's a room to establish a think-tank that will look at this issue, but one that is not necessarily funded by industry." So -- you know, because most of the players at that time were either funded by the industry or by governments that are -- oil governments. So we wanted to have an outfit that does not rely on industry money that can really look at this issue in a neutral and factual and really promote -- to public interest on this, on energy security.

**Greg Dalton:** We'll get into some of your ideas in a moment. Kate Gordon, how did you come to this?

**Kate Gordon:** You know -- sort of through a bunch of different paths. I have a degree in city planning from Berkeley, and as a planner, I was very focused on how cities are built and how we think about, you know, transportation costs and the inability of people to live near work, especially here in the Bay Area and how much time and energy and money people spend just commuting and on oil.

So I came to it originally from a land use perspective on transportation and thinking about ways that we could reduce those costs and that sort of that oil use and cost of gas. But more recently, I've become, you know, obviously very involved in the economic impacts of energy transformation in general. And a lot of that is on the electricity side, so, you know, replacing coal for instance with natural gas, with wind, solar and other things. But then, transportation is 40 percent or more of our carbon emissions, and my sense has been that there's been a lack of real focus there. I mean there's been some policies that have tried to get at reducing carbon intensity in fuels like here in California with the low carbon fuel standard. But generally, the discussion around climate has been on the electricity side, even though oil is this massive piece of the puzzle.

And so, increasingly, I've sort of started thinking there about what do we do on that side. Is it possible to actually reduce and liquid fuels or do we have to think about a totally new solution?

**Greg Dalton:** I think that's an area we might have some agreement today and we'll get back to that sort of the electricity and coal and those other issues. Eyal Aronoff, let's talk -- let's hear how you kind of came to this.

**Eyal Aronoff:** Well, I grew up in Israel. When I was four years old, I lost my father in the Six-Day War. And many years later, my mother remarried and moved here to the United States, and I lost my stepbrother and his wife in September 11. So, this was a big wake-up call to me, and I looked around to figure out who is doing anything about it. And of course, the first person I found was Gal Luft over there. He seems to have been the only expert in this field for the longest time. But then in 2008, I went to the Beijing Olympic Games.

I was a guest of the Chinese Olympic team. And talking to the Chinese people, we realized that they think -- the thing they want the most is to own a car. And then you start to calculate the numbers.

How many are out there that want -- wants to own their first car? And all of a sudden, it dawned on me that although we have national security issues, I am a big environmentalist myself, so I believe we have environmental issues with oil. We also have a gigantic economic problem in our hand with oil. And that really was the prompt that enabled me to create the Fuel Freedom Foundation.

**Greg Dalton:** Well, let's start then, because, Gal Luft, there's a lot of talk about U.S. supply, et cetera, and OPEC, but really isn't Asia and China driving this train, that the demand from China and Asia for petroleum will have a big impact on supply and prices, and really it's -- China is really the big player here?

**Gal Luft:** Well, China is a player as well as Japan a player in the 1960s and the 1970s. But guess what? You know, there was enough supply to go around and the Japanese economy and then the other Asian economies flourished, so I don't think the fact that there are many more people joining the party. That's our problem. And what we try to do, Anna Korin and myself in Petropoly, is to do something that actually has never been attempted before, and in sort of a logical way, and that is to look at the price of oil through the prism of how much money will the OPEC countries need in order to stay afloat economically. In other words, how much money do the Saudis need to balance their budget? Let's take Saudi Arabia as just as an illustration.

A country of 28 million people. Most of them work for the government. Very little private sector.

Forty percent are under the age of 15. They don't pay income tax. And they expect to get cradle-to-grave services from their government. And by the way, they happen to be the sixth largest consumer of oil in the world. Why is it important that they're the sixth largest consumer of oil?

Because the more you consume, the less you have to export. So now you want to ask yourself, how do you keep 28 million people happy and content so that they don't storm the palace, right, and you don't end up like Mubarak or Khaddafi? Well, you shower them with money. So you want to ask yourself, how much money does people are going to need to bring home to keep the system balanced?

So that's what we did with Saudi, with other oil-producing countries, and then we realized that what is really driving the price of oil is not the Chinese demand. I mean of course, there is demand, but then you ask yourself is that -- can that be met with supply? Well, that will have some impact on the price. But what we feel is that what really determines the price is the ability of OPEC to manipulate the price to a level that every time that we -- non-OPEC -- we increase our production like we do today, they decrease -- OPEC decreases their production, and we, through efficiency, we decrease our demand for oil, they respond by decreasing their production. So what you need to remember, the axiom is, "When we drill more, they drill less. And when we use less, they also drill less," just in order to keep the break-even price where they need it to be. And if we understand that, we understand that our set of responses over the past 40 years is not adequate.

And that's why we seem to base the situation that this country is less and less dependent on imported oil and our cars are more efficient than ever and we're drilling more than ever, and it hasn't had any impact on the price of oil. The price of oil is still around \$100. So clearly, something is wrong with our method.

**Greg Dalton:** Kate Gordon, you agree with that analysis?

**Kate Gordon:** I do. I mean I think that the point cannot be made strongly enough that we have enormous power in this global oil situation in terms of our demand. We are big users. Even though other countries are becoming big users, we are big users of oil. Still, it's what -- 25 percent of --

**Gal Luft:** Twenty.

**Kate Gordon:** Twenty percent of the world oil, and that using less has an impact. I mean I think this is sort of the mantra here at this point is the only way to deal with sort of both the national security implications that we're going to be talking about, the price implications that we're talking about and the climate implications we're talking about -- the only way to actually address that is to use less oil. So the question to me becomes "What do you do instead?"

**Greg Dalton:** But what I heard Gal Luft saying is that we can use less but it's not going to have a price impact? He may have some --

**Gal Luft:** Let me clarify this, okay. Using less has its advantages. It reduces your trade balance...

**Kate Gordon:** Right.

**Gal Luft:** It keeps more of your money abroad, so more money can be used for economic activity, jobs investment -- so I'm not saying we should...

**Greg Dalton:** We're not sending it to bad...

**Kate Gordon:** Well -- no. And using less means literally in your own budget using less. So you're spending less. So you displace the prices. It's like energy efficiency. The price per kilowatt hour

might be the same, but your energy bill is less.

**Greg Dalton:** Okay.

**Kate Gordon:** So it has an impact -- the climate impact is obvious because they're drilling less. If we use less, they drill less. If we -- if I use less, I pay less at the pump, and if we use less, the trade balance impact is positive. So there is a positive set of things that happen.

**Gal Luft:** But what is not going to be impacted, to my world view, is the global price of that oil.

**Kate Gordon:** Yes, I agree with that. I agree with that.

**Gal Luft:** That's my point.

**Kate Gordon:** Which is why we shouldn't be focused on that, is the thing to bring in. [Laughter]

**Gal Luft:** Yeah, I mean -- Newt Gingrich for example, he had this book a few years ago which basically summarized the old paradigm that I believe has collapsed. The title of the book was Drill Here, Drill Now, Pay Less.

**Kate Gordon:** Right.

**Gal Luft:** -- okay? Which means if we only drill more oil, we will paid less at the pump. And I'm saying we've done that, it didn't work.

**Kate Gordon:** It didn't work. In fact we paid more.

**Gal Luft:** Yeah.

**Greg Dalton:** Okay. So there's lots of good things can happen, but we're not going to bring down the price. Eyal, let's get you in here.

**Eyal Aronoff:** Yeah. Look. I mean one has to put things in perspective. I think we are already paying way too much for oil. Because if you think about it this way, compare for example our oil demand to our coal demand. We paid in 2011 \$35 billion for coal. We paid \$780 billion for oil products. So if the price of oil goes down, say from \$90 a barrel or \$100 a barrel down to \$50 a barrel, that's \$300 billion --

**Gal Luft:** Billion.

**Kate Gordon:** Billion.

**Eyal Aronoff:** -- billion dollars in the pockets of the American people. \$300 billion is \$4000-\$5000 for every family. That's more than the stimulus package that got us out of the big recession. And that's annually.

**Greg Dalton:** But what I've heard here is that the United States is and will be a price taker -- the influencing global oil price is not within the President or any American economic power, and so is the era of cheap oil over? Are we just stuck with high prices and that's --

**Kate Gordon:** Well, let's clear too about who -- in whose interest are high prices. So there's (a) the fact that this is a global marketplace and price that we can't affect price by an individual action here in this country for a bunch of reasons. But (b) high prices are absolutely in the oil companies' interest because they get more profit with high prices.

But also none of these unconventional oil and gas we're currently going after is economic unless they are high prices. I think the Bakken shale in North Dakota becomes economic around \$80 a barrel. So there's no reason to do it. There's no reason to go after it. The Monterey shale here in California -- huge reserves, extremely difficult to get at for a whole bunch of reasons. That's not going to be economic without high prices, so it's all self-reinforcing. The high prices drive the unconventional drilling, the high prices are kept up through a number of means. We're not bringing them down. My point here is just like that can't be our goal. We can't be fixated on bringing down the price of oil because that is not going to happen through anything we have any control over. We should be -- we should be thinking about how to move away from oil.

**Gal Luft:** I'm a bit surprised to hear that because I think that specifically for people who come from the climate side of it, if you don't bring down the price of oil, what you're going to get are the dirtiest of the dirtiest of fuels.

**Kate Gordon:** No, that's true. That's true.

**Gal Luft:** You're going to see people at \$200 or \$300 a barrel sucking oil out of those walls here because it's going to become --

**Kate Gordon:** I agree.

**Gal Luft:** So I think that what we're going to ask ourselves is is high oil prices good or bad for -- and for whom. And I will also add that I would separate between the international oil companies, what we call big oil...

**Kate Gordon:** Right.

**Gal Luft:** -- and the OPEC countries or the oil-producing [Crosstalk] --

**Kate Gordon:** State-owned --

**Greg Dalton:** State-owned companies.

**Gal Luft:** I think it's very important to make the distinction here to understand that there are two different animals. When you look at big oil, what we call big oil, which only happen to own about 8 percent of the world's oil, so they're really price takers here -- Exxon, Chevron, BP, Total -- all these companies. They're becoming increasingly natural gas companies.

**Kate Gordon:** That's true.

**Gal Luft:** John Hofmeister, former president of Shell, told me that Shell last year became a de facto natural gas company. So if you -- half of your portfolio is natural gas, you -- it is in your interest to shift some of the effort to creating demand for natural gas, you make more money on your natural gas even if it means less money on your oil, whereas a country like Saudi Arabia cannot afford to accept a deal like this. So I would just be [Crosstalk] I think we're talking about a very nuanced cast of characters, and they have two different interests in mind.

**Greg Dalton:** Eyal?

**Eyal Aronoff:** Look. I think that the paradigm of the environmental movement where it comes to oil use has to shift. The pattern has always been that if the price goes higher by taxes and by other means, demand will go lower and production will decrease.

**Kate Gordon:** Right.

**Eyal Aronoff:** Since the Oslo Code, the price of oil went up 400 percent. What happened? Demand increased, and production increased. Even in the United States, our own demand is decreasing, our production is increasing. Okay. So the paradigm we've started, which means higher prices is good for the environment because it reduces demand and reduced production has failed. We need a new paradigm. And what we propose is that paradigm is by keeping the price of oil -- you take out, as Kate said, you take out the incentive for the dirtiest of oil production.

**Greg Dalton:** Okay. So we agree that -- we seemed to hear you saying that high oil prices benefit certain companies. How about the OPEC countries? Saudi Arabia, for example, do they benefit from really high oil prices?

I mean I've always thought at some point, they're concerned about these new competition from other fuels becoming more competitive, it really -- they don't want it too high because then people try to get off the stuff that they're supplying.

**Gal Luft:** Which is why you see within OPEC, always tensions. But what are those tensions? The tensions are what we call the hawks and the doves. Within OPEC, the Saudis, because they have more money, could afford to live with \$90 a barrel. So they're considered to be the doves -- the price doves. Whereas the hawks, Iran, Venezuela, Algeria, they need \$105 a barrel. But the difference is really in degree, not in kind, okay, because they all agree that they need between \$90 and \$105 now, and, down the road, it will be much higher. So that is a term that they coined which called the fair price of oil. If you go to Google and you google fair price of oil, you'll see something very funny. Every year, it changes. You know, a few years ago \$35 was the fair price of oil and the Saudi Minister of Oil said 35 is good. The year after, it was 50, then it was 70, then it's -- now, he says \$100 is the fair price.

Now, what is the fair price of oil? The fair price of oil is what I call the break-even price of oil, and that is the price per barrel that they need to charge in order to keep their balance.

**Kate Gordon:** Right.

**Greg Dalton:** Regimes in power?

**Gal Luft:** Yes. They call it fair, I call it break-even, it's the same thing.

**Greg Dalton:** Are the Saudi oil reserves overstated? Are the Saudi oil reserves overstated?

**Gal Luft:** There's no idea that any living creature can tell what the situation with the Saudi oil reserves. And the reason is because there's -- the reserve data is a state secret. And they don't provide access just like most countries by the way don't provide -- Russia doesn't, most OPEC countries don't, all of them in fact.

And so who knows? I mean we don't know how much oil they have. Some of them don't even know how much the oil they have. And as we see from our own experience, the definition of oil is changing all the time. All of a sudden, you have something called tight oil. You know, I've been in this business for a long time and I don't remember people talking about tight oil. All of a sudden we have a million barrels a day coming out of this something that none of us really knew about.

So the definition of oil is changing all the time due to technology. And I think that the discussion of how much oil there is is not really relevant. The question is how much cheap oil there is. And I think that's what -- how much cheap oil there is at a point that we can take it and burn it in cars?

That should be our question, not how much of a commodity is out there.

**Kate Gordon:** It is interesting note to look at Saudi Arabia, I agree -- I mean of course we don't know how much they actually have, but it is interesting that they -- Saudi Arabia uses oil of course not only for transportation but also for electricity. And it is interesting that they've become one of the most aggressive countries in the world on building solar at utility scale, in part in order to stop using so much of their oil for electricity. They would say that it's -- for a bunch of reasons, I mean to conserve oil for sale. I'm sure there's a big one but it is sort of interesting. I mean it's a major national policy. It's not at all just sort of a drop in the bucket there. They're trying to build an enormous amount of solar in the next few years.

**Greg Dalton:** Kate Gordon is director of Energy and Climate Program with Next Generation, a think-tank in San Francisco. Also here at Climate One today, we have Gal Luft, co-author of *Petropoly: The Collapse of America's Energy Security Paradigm*, and Eyal Aronoff, co-founder of the Fuel Freedom Foundation in Washington DC. I'm Greg Dalton.

Let's talk about U.S. energy independence. It's often heard in the political debate. Is it attainable? And if it were magically attained, what would that mean? Eyal?

**Eyal Aronoff:** Well, the concept of energy independence is misleading for two different reasons.

In the electricity space, we're already independent, right? We don't import electricity unless we have market conditions where we buy some of the electricity from Canada. The problem of independence if there is one is only in oil. So to say energy independence -- it is nothing there. The question is about oil independence. And when we talk about oil independence, the question is independence of what? Okay? Is it independence of being able to produce your own oil or is it independence in the price of oil?

So look at Canada. Canada produces more oil than they need. They are oil-independent, yet the price they pay at the pump is exactly like the price we pay at the pump.

**Greg Dalton:** Well, it's a lot higher because the taxes -- but yes, so they -- but they --

**Eyal Aronoff:** Right. Exactly. Okay. And by the way, they don't drive less and consumption of oil is rising even though the price is higher. So the issue is really how to become price setters rather than price takers. For us to become price setters is oil independence.

**Greg Dalton:** Right. When people talk about energy independence, they often think about, well, we're not going to be hostile to someone who's setting the price or controlling the supply. Gal Luft?

**Gal Luft:** Well, I mean one good example is, you know, in 2011 there was a war in Libya. And the price of oil for American consumers went up by \$21 a barrel. How come? We do not import oil from Libya, why should we suffer? Why should we pay \$21 extra per barrel because the Libyans have a civil war? So it challenges you that it doesn't really matter because the price of oil is global. When it goes up, it goes up for everybody. I think the best way to understand the role of oil in our life is to use the salt analogy.

You know, we had a book a few years ago called *Turning Oil Into Salt* and -- because we really try to come up with a good way to explain the situation and -- and we came to salt because salt was for most of human history the most important commodity in people's lives because it was the only way that you could preserve food, right? Before the invention of refrigeration and canning, if you wanted to survive during the winter, you had to cure enough food with salt and wars were fought over salt and colonies were built around who has salt and -- everybody thought about salt. And there were all

kinds of places like Tortuga, Boa Vista, Touareg Island...

**Kate Gordon:** Right.

**Gal Luft:** Places that we don't even know where they are in the map but -- they were just as important as today's Abu Dhabi and Kuwait and Saudi Arabia. Why? Because they had salt.

So then came two simple inventions: canning and refrigeration, and they diminished the strategic importance of salt. But here is the funny thing. Today, we import more salt than we ever did before and we use more salt than we ever did before. Now, does anybody care where our salt is coming from? Do you know? Do you care? We don't --

**Greg Dalton:** I have some very nice pink Himalayan salt, yes.

**Kate Gordon:** Yeah, the pink Himalayan salt. [Crosstalk] That -- that's good stuff. [Laughter]

**Greg Dalton:** That has high carbon footprint, I'm sorry. Yes.

**Gal Luft:** If we are to hear about our salt dependency, it's more likely to come from our cardiologist than from our president, right? So the issue is here to reduce the strategic importance of --

**Kate Gordon:** Oil.

**Gal Luft:** -- of the commodity. Just like we diminished the strategic importance of salt and made it into just another commodity to trade, we need to do the same to oil. And that I think should be the core of the new energy paradigm.

**Greg Dalton:** And how to do that?

**Kate Gordon:** I just want to pick up on this energy independence question, because, to me, one of the big questions is not independence from other countries because I agree with everything these two have said, and they're -- they are the experts up here on geopolitics, but we are increasingly going to have to think about independence of resilience -- independence from or resilience to the volatility of the oil markets, which is extremely tied to climate change. So just to bring this back to climate, we had an oil disruption in higher prices when Hurricane Katrina happened, if a Gulf of Mexico event would happen, we would have significantly -- potentially now higher prices because of all these dynamics, but it would disrupt our oil supply at 30 percent of our oil coming through there. So there are climate disrupt -- so we're adding to climate change, disruption potential by drilling and using a lot of oil. We're more likely to have disruption in our oil supply because of climate change. And oil is inherently volatile anyway because of all of these things that can happen politically that happened in different parts of the world where we don't even get our oil but that affect our oil price and our oil supply line.

So my feeling about independence is we should be thinking about independence from that set of extremely volatile conditions that are sort of inherent to the oil supply chain. And independence there, how do you get to that? You really got to it by reducing the strategic reliance on oil which gets you to this question of what do you do instead. And what do you do instead is a huge question. I mean it is not a simple question at all. It's a -- we have an entire infrastructure. An entire way of doing cities built on this commodity, so it's a big deal. But I agree that it's, that's where we have to go.

**Greg Dalton:** Well, let's take a whack at how fuels -- other fuels could compete with petroleum. Talk about the obstacles and what has a chance. There's been a lot of fuels and we'll touch on some



of them -- corn ethanol, electric cars, et cetera. What has a chance? If oil is the problem instead of coal as Eyal said earlier, what are the chances to introduce some competition in the marketplace?  
Gal Luft?

**Gal Luft:** Zero if we don't change the cars. The problem is that we all talk about the fuel -- is it going to be ethanol or methanol or natural gas or electricity -- but we have cars we put every year on the road in the United States, 14 million cars that basically you open the warranty and it says you can only run me on petroleum. As long as that is the case, we are captive. Okay? So we have to change the type of cars that we put on the road. What OPEC fears most is competition. Okay. And I would explain what -- to give a positive example of where I think we need to go.

Look at electricity. When you buy a light bulb, okay, or any electrical appliance, the light bulb doesn't tell you you can only run electrons made from coal or nuclear or solar.

**Kate Gordon:** Right.

**Gal Luft:** It's -- it -- it -- it's commodity-agnostic. It doesn't care how you made the electrons that it uses. Our cars do care. They are not commodity-agnostic. They only like to drink petroleum.

**Kate Gordon:** Right.

**Gal Luft:** So what we need our cars to be more like a light bulb in a sense that they could accommodate energy sources -- different energy sources and have those sources compete against each other in more or less free market environment. Now why is it important? Once you have commodity arbitrage, different commodities can compete against each other, they compete over market share. Competition over market shares -- that's economics 101. Competition over market share brings out the competition over price.

**Greg Dalton:** Is that what's happening in Brazil?

**Gal Luft:** Yes, absolutely. And that's exactly what happened in Brazil, which is why by the way in Brazil, in 2008, just to remind the listeners -- in Brazil, most cars are flexible fuel cars. So they can run on any combination of gasoline and alcohol, okay. And they have a sugar industry, they make ethanol. But it's not important what they use. The concept is flexible fuel vehicles.

In 2008 in Brazil, when all of us were suffering through the high gas prices, gasoline in Brazil became an alternative fuel. Brazilians bought less gasoline than ethanol because they had cars that enabled them to shift on the fly from an expensive liquid to a cheap -- cheaper liquid. And, you know, two years later they had a drought and they switched back to gasoline. So the important thing is to -- that individuals are economic creatures.

**Greg Dalton:** Do those cars cost more?

**Gal Luft:** One hundred bucks more per car. (Crosstalk) --

**Kate Gordon:** And U.S. companies make a lot of them now.

**Gal Luft:** Yeah.

**Kate Gordon:** So we know how to do this. [Laughter]

**Greg Dalton:** So, there's been some attempts at flex fuel in the United States, mainly around corn, didn't go very well, Kate Gordon, in terms of -- there's a few ones -- basically if you live in Wisconsin,

you could do it. Otherwise --

**Kate Gordon:** [Laughter] My home state. So, I'm always happy to talk about Wisconsin. -- I am sort of having a whole sea of change on how I feel about this question. So it's a good time to talk about it, which is, you know, we're spending a lot of time in California thinking through this very issue. We have a low carbon fuel standard in California that requires that our fuel become 10 percent less carbon-intensive by 2020, and there's a big debate here as folks know about how to get to that. And there are people on one side that say the only way to get to it is sugar ethanol and you'd have to import it and there's life cycle costs and there's land costs, and there's another side of people that say, "Oh, but there's new innovations everyday in biofuels."

Now, both of those things are sort of true. The way I'm coming to think about this question is I don't know that if you take a climate perspective on alternative fuels, I can't actually think of a really good liquid fuel alternative. If you really take into account the land costs, the life cycle costs, the cost of aggregating when we know -- this is what happened with cellulosic ethanol.

The sheer cost of getting all of the corn stover or getting all the switch grass to one place, sorting through it and then running through an enzymatic process and turning it into something is extremely expensive. So, my feeling is increasingly that -- honestly increasingly that where we should be looking for technology and innovation is on the electricity side, electrification, and also on the vehicle side. But vehicles not just through engine conversion, but also just changing the vehicles, making them out of lighter material, making them more efficient, getting them to a higher mile per gallon standard.

I have a lot more faith frankly in innovations in those two places, in electricity and -- in electrification and in vehicle manufacturing than I do in the liquid fuel cycle.

**Greg Dalton:** Eyal Aronoff, you drive an electric car. Do you agree?

**Eyal Aronoff:** I drive an electric car. I should have two, I have one of the -- I drive the S number 17 of the production line. It's an unbelievable car.

**Kate Gordon:** Which is the Tesla.

**Greg Dalton:** That's a Tesla.

**Eyal Aronoff:** Yes, of course. Sorry. Once you drive a Tesla car, you don't really want to go to drive a gasoline car. It's the driving experience that is so much better. It's not because it's electric. It's not because it's environmentally friendly. And it's not because it has a gigantic screen that you can run your whole office while you're driving. [Laughter] It's exhilarating to drive. And hence, I think this will end up being the long-term winner. But think about it in other way. In my car, there are about 8000 little battery cells. If Tesla makes a million of these cars, which will make it one of the most successful companies, right, we will need about 8 billion of those battery cells.

The whole world production of cells like that are in the hundreds of millions today. And a million Tesla are not going to do anything to the price of gasoline, because every year we produce 19 million new cars, all running on petroleum.

So this process has begun. The process has begun, and it will continue because the product is better. But the rate of adoption, the rate of replacement of the fleet, the rate of ramp up of production capacity, the rate of building the supply chain, which is mining and all those other things that requires to happen, the rate is slower than we hope it would be. As a result, we will expect to see real changes of demand on oil because of electric cars in 20, 30 years.

The question is what do we do in that period -- 20, 30 years? And that brings us back to the liquid fuel issue.

**Greg Dalton:** The liquids are a bridge to -- okay. To the ultimate electrification. Okay.

**Eyal Aronoff:** Exactly. So we need to look at intermediate solutions. We know where we are going. We need to look at intermediate solutions. Now, in this 20-30 years, there is a good likelihood that the car that is bought today, hopefully in 20 years, will still be on the road. Right? So what we need is we need to enable the cars that are already being in production and the cars you guys already own today to run on fuels not made from petroleum.

Now if we would have said here 10 years ago, they would say that this could never happen because the car was hardwired, it was built to run on one fuel. Okay. And in addition to that, the replacement fuel that had to compete with oil were all very expensive. So two big things happened. The first thing that happened is that car companies realized that the international market for cars is bigger than the U.S. market for cars.

And as such -- and every country has different fuels, right? So as such, they went to something they call the global platform. So they removed everything that has to do with regards to fuel and they put it in the computer that runs the car. The engine doesn't know anything about fuel. Remember we used to have timing belt? This was a real actual belt?

**Kate Gordon:** Yeah.

**Eyal Aronoff:** All of this stuff is all gone. We have computer. When you press the accelerator, it's just like pressing a keyboard on the computer. And the car says, "Oh, he's trying to accelerate," or "she's trying to accelerate. Great. Let me just do this. And this is how you do it.

Okay, so we can upgrade the software on the car to make cars that are on the road today to work exactly like cars working in Brazil. In Brazil, you have Mercedeses, you have pick-up trucks, you have Ferraris, you have Lamborghinis, all of them can work on ethanol fuel.

**Greg Dalton:** So where is the resistance? Why isn't it -- Gal Luft?

**Gal Luft:** I think that it's dangerous when you talk about ethanol because ethanol is very charged word -- and everybody has a position about the E word, and America is basically divided with the ethanol haters and ethanol lovers, depending on where you are. I would like to talk less about ethanol and more about the other alcohol that I think has huge potential both from economic and from an environmental perspective, and that is methanol.

**Kate Gordon:** Methanol -- yeah.

**Gal Luft:** Why methanol? Because the big play today is natural gas, okay? This is what we have a lot of, this is what is very cheap, and we don't use it in transportation, only less than one percent of our natural gas is used to move cars. If you think about this, an electric car in many parts of the country is a natural gas vehicle.

I mean you make the electricity from natural gas, then your electric vehicle is a natural gas vehicle.

But in picking these things that a natural gas vehicle is a vehicle that has a canister with gas compressed in it. The other ways of using natural gas, and that is to turn the natural gas into a very cheap liquid called methanol. And this methanol, just like ethanol, can be mixed into our fuel supply and blended in and reduce our petroleum dependency, and run on flexible fuel cars like the cars that are sold in Brazil.

But the research on Petropoly, on the book, took me to China and to a province called Shanxi. Now, Shanxi has more people than California. So it's not considered the biggest province but still, it's very large, and go to any fuel station in Shanxi or any other 14 provinces where they use methanol, and you'll see that the Chinese are already blending 15, 30, 45, 85 percent methanol into their fuel.

Now, the Chinese, because they don't have natural gas, they're making it from coal, which is much dirtier process. But if you make it from natural gas, it is superior to gasoline on all level, both in terms of SOX, NOX, all particulate emissions as well as CO2 emissions. So I think that unless you're looking for a perfect solution, sort of 0-0-0, I think that methanol is a very, very bridge -- a very good bridge solution since it's cheaper, it reduces your greenhouse gases and emissions and it's scalable, which is the most important thing -- the scalability. Because really, a one or two percent solution, that's not good.

It makes a feel-good, but it's not going to make a difference. We need something that can be scaled.

**Greg Dalton:** Kate Gordon, is methanol the answer? And can it be purchased in the United States today?

**Kate Gordon:** Well, on the first question, let me just say I actually think that natural gas does have a place in this whole conversation, but I just want to contest for a second -- we don't actually know that natural gas is less greenhouse-intensive than a number of other options at the moment. And the reason we don't know that is because the -- in the United States, natural gas is exempt because of the 2005 Energy Bill, it's exempt from the Clean Water Act, it's been exempt from a number of Clean Air Act provisions. There isn't a standard systematic way to measure things like the methane leakage from the natural gas extraction operations. We do know from point-by-point source data that the natural gas leakage is significant in some places, in part honestly because a lot of the natural gas producers, unlike on oil, are small wildcatters who are not necessarily using the best technology and not necessarily following the best standards.

So there's a really bigger question when it comes to natural gas of what is the actual methane leakage and what do we do about it. I believe we can figure that out and I believe we can do something about it, but -- so I'm only comfortable with it as a solution after we figure that out and after we've contained methane emission leakage. Because methane is a big deal when it comes to greenhouse gases. It's basically got a short half-life. It comes into the atmosphere right away. It's a bigger deal than carbon in our immediate lifetime. So I would just say that caveat is a big caveat, but I do believe it's fine -- it's determinable and regulate-able and we need to do that. And then I feel like it's part of the conversation.

**Greg Dalton:** Kate Gordon is director of Energy and Climate Programs at Next Generation, a think-tank, and also energy expert with the Wall Street Journal. We're talking about oil markets and transportation at Climate One. I'm Greg Dalton.

Let's talk a little bit more about Detroit and Houston. Do you think that there's -- Kate Gordon, do you think there's more innovation coming out of Detroit and at grappling with this issue on the car side than there is on the fuel side?

**Kate Gordon:** Oh, yeah. I mean just take a quick look and, you know, we should hear from you two, but take a quick look at these industries. They're very different. I mean when did we see all the innovation coming out of Detroit? It was when the car companies were totally backed up against the corner and potentially losing their entire market share and bailed out by the government. So, you know, these were companies in distress, that needed a new model, and then we had the CAFE standard that was passed and they had a huge kick in the pants to get a new model and bring down

emissions.

That's a -- that's a very different story than the international oil companies. The international oil companies are not suffering right now. They are not up against a wall. They are not desperate. They are not in a position where they need to negotiate particularly. Oil prices are high, natural gases are a booming new market, they have a new -- in fact, climate change is good for them in a number of ways because it's reducing oil polar ice caps so they can now get through a bunch of waterways they didn't use to be able to get through. They are doing pretty well. I just don't see them having a push toward innovation particular. I don't think they're going to be the answer on this frankly.

**Greg Dalton:** Gal Luft.

**Gal Luft:** Greg, you asked up to disagree and I find it very hard to do if -- until now but [Laughter] at the moment, I'll disagree with Kate. I think you may not like the oil industry's innovation, but to say that they're not innovate, it's -- I think -- let's look at what they've done.

**Kate Gordon:** No -- and I'll be clear. They're not... they have a huge incentive to innovate to keep using their products. They do not -- what they're not going to do is become different kinds of company.

**Gal Luft:** Yeah, yeah. Sure. And why -- and why would they? Why would they? I mean they're not supposed to produce shoes. They are there to satisfy their shareholders.

**Kate Gordon:** I -- no. I'm not blaming them for this [Crosstalk] I just think they're -- there are bunch of reasons why they're not the answer to getting off oil. That's been -- [Laughter]

**Gal Luft:** No. I understand. And we should not look up to them --

**Kate Gordon:** -- and why would they. [Laughter]

**Gal Luft:** Yeah. I mean let's -- but I just -- I find it's a very strange position I have to defend them but they are very innovative I think that -- when you look at what they are, pulling out of the ground and depths of -- going into the ocean and doing those -- amazing stuff.

So it requires a lot of innovation. In fact, some of the most innovative players -- the fact that we don't like the outcome is a different story.

**Kate Gordon:** No. And I -- and we don't actually disagree. So we couldn't disagree but [Crosstalk] -- [Laughter]

**Gal Luft:** So we need to work hard but -- but the thing that -- where I feel that there is a sea change or -- look, I listened to the CEO of Exxon a few months ago. He gave a speech before the Council on Foreign Relations. And he said something very interesting on natural gas. He said, "We're all losing our shirts." Okay. So everything that they make on oil, they lose on natural gas. So I think that as they become de facto natural gas companies, they will be more and more inclined to look for demand because -- look. Natural gas, if we don't find ways to use it, it will be exported to Asia. And that's why we see such a push today for LNG. Because they need to get -- at \$3 per million BTU, you can't break even. You need the price to be much higher.

So either you export it or you create ways to use it domestically as chemicals, as fuels, as fertilizers - - something to build American industry. But one way or the other, it will find itself used either by us or by the Japanese or Chinese or the Koreans or who knows where it's going to end. But --

**Greg Dalton:** Let me pause for just one second. We're going to continue for a moment, put a microphone up here to invite your participation. If you'd like to join us with one one-part brief comment or question, we'd like to have you join us. If you're just joining us on the radio, our guests today at Climate One are Eyal Aronoff, co-founder of the Fuel Freedom Foundation, Kate Gordon with the Next Generation here in San Francisco, and Guy Luft, co-author of *Petropoly: The Collapse of America's Energy Security Paradigm*.

**Eyal Aronoff:** Greg, I just wanted to say what's happening to us now, because the price of natural gas is so low, it's worthwhile to burn it rather than to use it. So we are flaring it in mass quantities. So that -- what's going on is we get the liquids out and we flare the gas. So the motivation to use a fuel like methanol is multiple folds. First of all, it's a high-octane fuel that will enable this innovation in fuel economy. Today, the car companies are hamstrung by the low quality of the fuel that is produced. Gasoline is a low-quality fuel, that's why racing drivers don't -- I mean they run on alcohol fuels. So, this will provide much better leg up in order to get a higher quality engines, higher quality combustions and so on.

**Greg Dalton:** Can it be purchased in the United States today? Methanol?

**Eyal Aronoff:** Methanol is the largest liquid commodities that is not a fuel. Because it is the precursor of a lot of the petrochemical industry.

**Kate Gordon:** They use -- the chemical industry is --

**Eyal Aronoff:** The chemical industry use it in mass quantity.

**Kate Gordon:** It's not purchasable as a fuel, though.

**Eyal Aronoff:** It is illegal to be sold as a fuel.

**Greg Dalton:** So there needs to be some law change to make this -- to make this happen. Okay, I [Crosstalk] --

**Kate Gordon:** Just a little thing. [Laughter]

**Greg Dalton:** Some legal barriers that -- let's -- welcome to Climate One. Let's have our audience question.

**Peter Gisela:** Hi. My name is Peter Gisela. I'm interested in the question about alternative strategies for educating the general public on energy concerns, especially the topic you're interested in. About 30 years ago, I proposed the Youth Energy Corps based upon -- using the selective service program as the leverage to get youth involved in community service activities, and 10 years ago I asked Franklin Orr of the Stanford Energy Project if he had about 200 youth per congressional district across the country year after year interested in energy projects, what activity would they should be engaged in.

And he said that conservation and solar technology would be small efforts of positive impact but education -- understanding the energy consumption in their congressional districts and communicating that to the general public is --

**Greg Dalton:** And -- and your question?

**Peter Gisela:** So my question is, have you considered alternative strategies for educating the general public on these concerns of energy issues?

**Eyal Aronoff:** Well, I can say that first of all, this is what we are doing right here. We are now talking to the general public. And -- but in Fuel Freedom Foundation, in our foundation, there is a very large portion of our budget is dedicated to educating the public. Of course, the issue is always to come first with good policies, with good science, and with good technologies. And then you can actually go to the public and tell them, "Okay, this is what you've actually got to do." And that has been, by far, the highest barrier. Now that we have a plan like that, that is the thing that is coming next.

**Kate Gordon:** I have to say that I really --

**Greg Dalton:** Kate Gordon.

**Kate Gordon:** -- quickly on this. I think there's a level -- and we talk a lot to I would say the informed, educated public. We hear a lot about American education and how people don't know that there are three branches of government and they don't know -- can't even name one, it's actually short of shocking, 30 percent of adult Americans can't name one branch of government. But we don't hear about the shocking numbers on the energy side, and it is actually true that most Americans can't tell you where electricity comes from, where fuel comes from, what impact that has on --

**Eyal Aronoff:** From the wall?

**Kate Gordon:** The environment --

**Eyal Aronoff:** From the wall? [Crosstalk]

**Kate Gordon:** From the plug in the wall, exactly. I mean that's -- there's very little education on this stuff, and I honestly -- it is actually true that the environmental sciences textbooks that are used in high schools across the country are -- many of them are written by the oil, gas, and coal industry. So the extent to which there are -- there is education happening at high schools, it's education happening in -- with particular bias, toward the status quo and toward we currently use our energy.

So I think it's a huge problem. It's not something I personally work on but we do have a children and family side to our think-tank and it's something we've talk about a lot, because it's a real sort of foundational issue.

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

**Adam Bergman:** I'm Adam Bergman. I've been around the sector around clean transportation probably the last eight or nine years. One thing you guys really didn't touch on which I think is a huge issue is infrastructure, and who's going to pay for it. One of the things I think politicians have really failed on, and you guys talked about in the beginning, was the amount of cost above what actual production cost is that you're selling and how much money is actually were sent to Saudi Arabia for no apparent reason outside of the fact that's what it goes by. There's no supply and demand continuum about an actual price.

So how do you take potentially and convince the public that we're sending all this money unnecessarily and actually take some of that or find another way to build out this infrastructure.

Because clearly without it, it's going to take as you -- I think it's potentially 30 years to get us to places with either natural gas vehicles or even with electric vehicles?

**Greg Dalton:** Thank you. It's going to cost a lot. Eyal Aronoff?

**Eyal Aronoff:** Yeah. Infrastructure is a very big part of this discussion of course. And one needs to understand that the way that the systems is currently geared, even if you today can produce a fuel that can run on cars for less, you will not be able sell it in the market. And the reason is that the fueling infrastructure is sort of a -- well, it's not exactly a monopoly but it is governed by the brand. Okay. So under the canopy, you can only have product produced by the brand.

So what we need to do in order to break that is once we make these fuels legal and we make the conversion legal, is to go to the Wal-Mart, the Costco, the Safeway, 7-Eleven -- those vendors sell gasoline as a last lead to get people into the stores.

The new fuels, because the energy content is slightly lower than gasoline, will require more trips to the store it will provide great motivations for these people to stop the fuel.

**Greg Dalton:** Gal Luft, I also want you to comment briefly on a hundred years ago when there was fuel choice and competition for transportation.

**Gal Luft:** Sure. A hundred years ago when the first car started, 30 percent of America's cars were run on steam, 30 percent -- another third was running on liquid fuels and the rest ran on batteries.

So it's interesting that when the whole era of motorized transportation started, there was a lot of choice going around. But then came a few decades of world wars and Depression and the Prohibition and lots of droughts in the Midwest and all kind of things that really consolidated what I called petropoly -- the petroleum monopoly, and that's where we are today.

And that was all good. And as long as gasoline was very cheap, which is up until about 10 years ago, nobody cared about this and -- but that changed recently when prices are going higher and higher.

**Greg Dalton:** It was good until we didn't know about climate either, too.

**Gal Luft:** Yeah. And -- just for the role of the government in this, and I think we all have to remember we live in an era in which government is not as generous as it used to be, which is in some ways, I think, is a good thing but I chose to start the book with Milton Friedman and ended with Friedrich Hayek. Because those are two libertarian thinkers who thought about -- a lot about the role of government. And I just want to read you the quote from Milton Friedman.

He said that that "The first and most urgent necessity in the era of government policy is the elimination of those measures which directly support monopoly." That's Milton Friedman. So what are the measures that directly support monopoly? The petroleum-only vehicle is one of the measures that support and enables a monopoly. And it's actually very important thing to remind to Tea Party, GOP members of Congress who tout the free market and the free market and the free market, that one of those places where you really liberate the market is to open cars to competition so that commodities can really compete against each other. And that's a role for government, and it doesn't really cost you that much because if GM says that it cost them \$70 per vehicle to make it flex fuel, that's a very, very low-hanging fruit, okay?

So let's start off by opening our cars to liquid fuel choice, move into electricity and others, these things need to run in parallel. It's not one or the other. You know, GM Volt can also be a flexible fuel vehicle. There's no -- there's no reason why it shouldn't have both. It's not one or the other. That's what -- we can have both.

**Greg Dalton:** We got about eight minutes and two questions. Let's get these in. Yes, sir. Welcome to Climate One. Let's have your question.

**Male Participant:** Thank you. First, a shout-out to a fellow urban planner from the Midwest here,



which really relates to my question. A lot of the solutions I've heard deal with technologies and fuel types and not really with land use. Our communities over the last 70 years have really gone from pedestrian-centric, transit-centric to auto-centric. And so I'm wondering why in the next few decades, we can't then reverse that trend. I didn't hear that as a solution.

**Kate Gordon:** No, I mean --

**Greg Dalton:** Kate Gordon.

**Kate Gordon:** -- It's -- it's a great question and it's where as I said I started on this whole thing. And you know what's interesting about the land use question is that in some ways, it's actually changing -- we don't think a lot about the relationship between the mortgage crisis and oil, but actually, there is a relationship in that a number of places that got extremely sprawl-oriented in the era of cheap housing, have now shrunk. Again, Detroit is a prime example of this. And Detroit, they're actually filling in basements -- knocking down houses and filling in basements and returning outer Detroit to agricultural land. That's an extreme example, but we see some of these here in California, too. And companies like BMW, which I'm actually really interested in, are planning their new cars for this new reality. They think that we're coming back to an era of megacities where there's really -- there's more city density and more people living in urban areas, and that -- and they're thinking about new car designs like their megacity vehicle, which is a carbon nanofiber vehicle, electric car, and what they are doing to deal with range anxiety is people who own that car have access to fleet of regular BMWs, which is basically their Zip cars.

So if you want to go on a road trip, you just get a different BMW to go on a road trip. But it's not your car, they bring it out to you, and I think that's kind of genius because it's designing for a different kind of city and different kind of lifestyle, but they really feel -- and they spend a lot of time thinking about this no money invested in it -- they actually think cities are changing, and I think that's an interesting idea.

**Greg Dalton:** The idea of sharing rather than owning. In fact, if you'd like to podcast this and other climate one programs, they're in the iTunes store, we had a whole program under Borrowed Wheels, Sharing Economy, and mobility as a service rather than a depreciating asset -- metal you put in your garage. Let's have our next question.

**Philip Morrison:** My name is Philip Morrison. I actually would like to you guys to go back to the issue of price.

I'd like to elaborate more, one, on I didn't hear any of you guys talking about policy; and two, the catch-22 between -- you lower the price and you do take away all the dirty fossil fuels from the competition, but at the same time you also kill away -- kill the good fuels, for example. Alternative fuels that are trying to enter the market that initially have a higher price. So one, how do you deal with this price issue that we do wanna lower the price but we don't want to kill alternative fuels; and two, where does policy fall in this whole new dynamics?

**Eyal Aronoff:** Okay, so leave the policy question to Gal here, but just on the price on replacement fuels. So what we think is that the biggest opportunity in any market is to be able to capture the big part of the market. What we have been actually seeing in the replacement fuel world is everybody is fighting on the periphery, on the renewable fuel standards, which is 10 percent of the fuel. So everybody's fighting for the 10 percent rather than saying "No, we are going to try to conquer the vast majority of the market," which is the 90 percent. What happens is if you reduce -- if you enable competition and your fuel of choice say can be a peer at the pump, so the idea of competition is not just the cog and run on any fuel. It's that you as consumer can choose any fuel.

So if you and your friends want to buy for example only fuel made from algae, only renewable fuel, only few made from corn, only fuel made from the sugar, you can decide to go to the gas pump or to build name, make a buying group and obtain the fuel. Today, this is illegal.

**Greg Dalton:** So what's going to be required? Is this going to require Congress to reduce some of the legal barriers to new entrance?

**Gal Luft:** Yeah.

**Greg Dalton:** Gal Luft? Is that --

**Gal Luft:** Not only Congress, also the administration, and a lot of it is happening at the EPA level. There are a lot of barriers to entry.

Look, what we want is a situation which like in our food consumption, you know. We all buy food. We all have preference when it comes to food. Some like organic foods, some -- and were willing to pay more for health, were willing to pay more for religious reasons. We have a lot choices when it comes to our food choices and preferences. And we all value things differently. We want to have the same situation with fuels.

And the best way to compare fuels, by the way, that's one of the mistakes that we've been making all along is that we always compare fuels on a miles per gallon metric, how many miles that can go per gallon. It's a very wrong approach to fuels. The economist in me would like to see our valuation of fuels based on how much we pay to travel one mile on a fuel. That's the only way that you can compare electricity and liquids and gas and everything -- cents per mile. That's the only way that you can do apples to apples comparison.

So the -- what we wanna do is first of all open the car to competition through the introduction of an open fuel standard. What does an open fuel standard mean? It's very simple legislation that says very simply that you cannot sell a car in the United States unless it offers you some choice. And without choosing any winner, without dictating to the automaker which technology to choose. If they want to do electric, they do electric. If they want to do flex fuel, they can do whatever they can, and there'll be different markets for different products, by the way. I don't think that there should be one silver bullet here.

So that's an open fuel standard. It doesn't cost any money, no tax incentives, no subsidies. That's on the car side. On the fuel side, the most important thing is to eliminate the barriers to entry to fuels.

Assuming that they are complying with clean air regulations and with safety of course and -- you know, we don't want to kill people but assuming that they are at least as good as gasoline, why can't we allow them to compete? We should open the market. Let's see competition in fuels that will drive industry, investors -- imagine to yourself, you want to invest in the production of a fuel, but you know that the cars cannot run on it. Why would you invest in half a billion dollars in building a methanol plant if the cars cannot run on it?

But if you know that from year X, the cars will be able to run it, that makes sense to begin to invest, infrastructure follows, the whole market begins to grow organically, bottom to top.

**Greg Dalton:** That's already there. There's a class of fuels that are coming into the entry -- there's a class of fuels called drop-in fuels that can run through existing pumps and existing engines. And Kate Gordon, it's been a disappointment. It hasn't really taken off.

**Kate Gordon:** I mean I think that the -- as various people have pointed out here, audience and us,

there isn't an infrastructure that supports this right now. It's -- there's -- new entrants to the market are having an extremely hard time in the current infrastructure, which is extremely petroleum-focused, so it is hard to drop, it is hard to get an infrastructure that's oriented one way and owned primarily by people who are oriented one way to drop in to new -- to embrace them, I guess.

**Greg Dalton:** And there's the financing, isn't there, for a billion-dollar refinery to do that stuff?

**Kate Gordon:** It is also extreme -- it's a whole other show, but it's extremely hard to commercialize technologies in the United States. We have a big gap between the big valley of death between pilot stage, new technologies in energy and a bunch of other fields and between commercializable scale. So --

**Greg Dalton:** Eyal Aronoff? Last word?

**Eyal Aronoff:** You can look at it in two different ways. The first thing is it's really, really hard to assemble gasoline from independent components.

**Kate Gordon:** Yeah.

**Eyal Aronoff:** The thing that took nature hundreds of millions of years. It's really, really hard to do. That's why we're looking to open the market for small molecule fuels, which we call alcohol fuels.

It's that much easier to do. You don't need 21st century biology to do it. You can do it with 19th century chemistry. This is famous Gal Luft sentence, by the way. So one thing is to reduce the barrier is to reduce the complexity. That's the first thing. The second thing is as we said before. Even if you can produce the drop-in fuel, nobody wants to buy because the supply chain is owned by --

**Kate Gordon:** It's set up for something else --

**Eyal Aronoff:** -- by existing monopoly. Okay. So you have to open it up and let the provider of fuels access to the consumer.

**Greg Dalton:** We have to end it there. Our thanks to our guests today at Climate One. Eyal Aronoff is co-founder of the Fuel Freedom Foundation in Washington D.C. Kate Gordon is director of Energy and Climate Program at Next Generation, a think-tank here in the Bay Area, and Gal Luft is co-director of the Institute for the Analysis of Global Security and co-author of *Petropoly: The Collapse of America's Energy Security Paradigm*. I'm Greg Dalton. Thank you joining us at Climate One today.

[Applause]

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