BOLD STEPS IN THE RACE FOR CLEAN ENERGY

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VAUGHN: Hello everyone and welcome. And first off, our sincerest apologies for the delay. We had a bit of trouble connecting today. Welcome to our web discussion, *35 Bold Ideas to Win The Clean Energy Race*. I'm Kelly Vaughn and I am here with our CEO Jules Kortenhorst and Rocky Mountain Institute's Cofounder and Chief Scientist, Amory Lovins. We had about 1,000 of you sign up to join this webinar today, which is incredibly exciting. Thank you for joining us.

For the purposes of housekeeping, we would love for you to submit your questions using the chat box in your GoToWebinar dashboard. We hope to get to as many as possible, but since we have so many joining us, we might not have the opportunity to address every question today, and we will make sure we follow up with you and engage further.

Kicking things off, why are we here today? We are really in a very exciting but also very critical time for both Rocky Mountain Institute and the world in our race to a clean energy future.

As we celebrate our 35 year anniversary as a nonprofit organization, first I'd like to turn to Amory and ask what over the last 35 years has really inspired you and showed you that there is a reason to maintain hope to really show that this clean energy race can be won? What are those most compelling proof points that you'd like to share with our audience today?

LOVINS: We've had, I think, gratifying success in launching revolutions in the efficient storage and use of energy. And that includes efficient and superefficient buildings and net-zero buildings. Very efficient industries are raising the bar quite distinctively in many sectors. Superefficient and electric autos and now shared and autonomous mobility as a service business models. And reconceiving the whole electricity business around efficient, distributed, renewable, and resilient energy supply. Those are all well underway.

The world has had flat carbon emissions for three years running with three percent a year economic growth thanks to a combination of greater energy efficiency, some structural change (especially in big economies like China), and of course renewables now being 55 percent of the new generating capacity the world added last year. It keeps getting cheaper and as it gets cheaper we buy more and that makes it cheaper and we buy more. Well, that positive feedback is just running away. The forecasters can't keep up.

In efficiency, we've figured out how to make big savings cheaper than small ones. We get expanding returns there too. Then combine this with some powerful policies, particularly not just in the market economies like our own where we have competitive electric markets and so on, but also in places like China, which has shifted very decisively toward efficiency as a global strategy. We see the same thing emerging now in India where going renewable is cheaper than coal. And you know, those two countries were responsible together for 86 percent of the new coal-fired power plants built in the last decade.

Now they've got over 300 billion watts in stranded assets because they're realizing they won't need them and it's cheaper not to have them. They're running the ones they have a lot less as well as renewable strategies taking over. This isn't easy and there's still a lot of hard work to do. But the world is now on the right track. It just needs to do it more, better, faster.

VAUGHN: There are indeed some very compelling proof points that the clean energy race can be won. We held a similar panel discussion with all of you about six months ago on a similar topic. Given that so much has changed since December, I'd like to turn to you Jules and ask, over the past six months, what are the major shifts in global markets that either threaten or provide confidence that this clean energy race is clearly moving in the right direction?

KORTENHORST: Of course when you look back at the past six months, you have to acknowledge an important transition is that we now are under a new administration here in the United States—one that in many ways is looking at a completely different, and we would argue outdated, paradigm about the energy system. Their emphasis on revitalizing coal, their focus on accelerating access to new lands for coastal fuel exploration, and also their disregard for the opportunities of energy efficiency forces us all to wonder, "Is that really the direction that the United States wants to go?"

At the same time, the distracting contrast with the world around us is really quite clear. Last year in Marrakesh, when countries were together a year after Paris, there was a very clear commitment from country after country after country to stay the course. A commitment, for example, from China and India (that Amory was already referring to), is visible both through the on-the-ground work that they are doing to accelerate the deployment of renewables and energy efficiency, but also in how they are now working together to drive innovation. Literally China and India have committed to each other to collaborate in accelerating energy innovation.

Country after country are agreeing that this is the direction of the energy transformation. They acknowledge that clean energy is going to lead to a more competitive economy and they want to be part of that. But it's not just at the country level. The increasing role of cities and provinces or states is also important to note. Just two weeks ago, Mayor Bloomberg brought out a book that emphasized the role of sub-national governments in accelerating the energy transition.

Excitingly, just yesterday, the city of Atlanta, Georgia, announced a new commitment to be 100 percent renewable energy by 2035. I mean, folks, this is Atlanta. This is not Boston, Massachusetts, or Palo Alto, California. So this is spreading where people are recognizing that a renewable-based and efficient energy system is more attractive, is more competitive, is more resilient, and therefore the way of the future.

We also see corporates playing an increasing role in this transition. We have been working with now over 200 members of our Business Renewables Center to support the buying of renewables across the United States. More and more companies are looking to be part of that transition. All of this is showing huge progress in the cost-effectiveness of the new energy technologies.

I attended the Bloomberg New Energy Finance conference last week, where Bloomberg New Energy Finance gave a preview of their new data coming out on the learning curve for solar and for batteries and for wind.

The learning curve, it is ruled that every time you double the installed capacity of a certain technology, the cost comes down in a certain percentage. And for solar, we already have a long track record since the '70s. Recently we all assumed that solar was coming down by 24 percent every time the globally installed capacity doubles. Bloomberg now expects that number to go to 28 percent. Similarly, we see a massive acceleration in the cost-effectiveness of offshore wind and an acceleration in the cost-effectiveness of onshore wind going from 14 percent to 18 percent.

Batteries is another technology where we've been tremendously surprised, and we've had to update some of our models because the cost of battery storage is now so much lower than what it was even in our forecasts for this year, one year or two years earlier. These trends are accelerating and are driving faster and faster deployment on a global scale.

All of this is very hopeful news. It certainly puts into question what direction the United States federal government might take. But at state and local levels—and around the world—we've seen an accelerating trend that is just unstoppable.

VAUGHN: Which makes it exciting for RMI to be in a position where we depend on market-based solutions to truly drive towards this clean energy future. Amory, in that light, how would you respond to Jules's comments about some of the uncertainties that the U.S. political situation has placed on our mission today and in the future, but meanwhile all of these very promising market trends are somewhat going to the beat of the same drum?

LOVINS: Well, when you have one nation out of 194 in the Paris agreement with a very different view of energy market realities than others, I think you're bound to say that however much power they think they have, they won't be able to get done a lot of the contrary moves they have planned, just as they've been frustrated in other ways by existing laws, practices, and market forces.

But you know, in the United States we have a system of government brilliantly designed by some very smart people 200 odd years ago to make major dramatic change impossible at a federal level. They did a really good job of it. And therefore, as I articulated in my remarks just after the election, we need to remember that the president is not the federal government. The federal government is not all government. In fact, most of our energy policy has long been made at the state and local level in this country. And government is not the only (or I would add even the most important) actor in energy and climate policy.

There will be a lot of turbulence within the president's party as well, because some of the greatest employment-adding industries are renewables in states like Texas, the national leader by far thanks to now Energy Secretary Perry and Iowa Senator Grassley. And those interests will be vigorously defended. But I think market forces will win and through all the turbulence, the same trends will continue. To the extent that the United States forsakes any territory in policy or markets, other countries will happily vacate, or excuse me, occupy the vacated space and turn it to their own competitive advantage. One way or another, the job gets done.

KORTENHORST: Kelly, here is an interesting illustration of some of the points that Amory just made. A big part of the emerging debate at the federal level is our ability to maintain a stable electricity grid in the face of a higher and higher penetration of renewables. It is a very valid concern and an important question. We have been arguing for the longest time that an electricity system that is based on distributed, renewable resources—and a broad variety of both power generation and power demands—yields even more stable and secure systems.

But there's some uncertainty around this in the current administration, and Secretary Perry has just asked for a review on this matter. Now, his thinking is that the way in which we create stability in this emerging electricity system is by reverting back to centralized busload power. But Amory, you were just talking to me about a new technology you recently saw that enables us to operate a much more stable grid by virtue of solar power being much more attuned to the variability of the grid. Maybe you can talk about it. It is just one of the indications of the tremendous amount of innovation that is happening in the space.

LOVINS: Yeah, now there are microchips headed for market that enable a distributing technology like for solar panels on the roof producing solar energy to look at the environment around them and lock

on to the frequency you want, the voltage you want, and heal any faults in the network and tune themselves up to stabilize it under those conditions. In other words, distributed intelligence rather than the central planning model the grid has grown up with where there's a dispatcher somewhere telling all the electrons where to go.

This way, with the distributed intelligence, even if the grid goes down in some places or many places, individual microgrids will continue to operate. That's actually the way my house works. It's the way the Pentagon aims to power all its military bases, because they need their stuff to work. And it's a good illustration of energy meets information technology (IT), and how IT is meshing up with energy. It makes systems smart, and enables them to have these properties of cost reduction, transparency, choice, resiliency that we could only dream of. Now that's coming together with new business models, new financial tools, and new ways of settling transactions.

It's a very exciting time. And I think it's also significant that the Energy Transitions Commission, with Jules's support as a Board Member, just released a new report and energy projections a few days ago. I was in Detroit with Jules and the Chairman of the Royal Dutch Shell Group, who called this a full-throated call for a largely or wholly renewable future coming. He was among other leaders from the oil, gas, and electricity industries saying, "This is feasible, it's profitable, and that's where we're headed."

VAUGHN: That is along the same lines of a question that came in. We have a group of supporters, our National Solutions Council, who engaged with us ahead of this webinar and helped shape some of the topics that we wanted to discuss today. Judd Russel, one of our supporters, actually brought up that very issue about when we would start to see us move from central-sourced electricity to a more distributed system. And Amory, I always love to point back to your age-old adage, that's it is not about motivations but outcomes, in that some of the examples you brought up were for the purposes of increased resilience. I think that's incredibly important to keep in mind this day and age.

LOVINS: On Forbes.com, I just posted another blog last night on whether this new code word for coal and nuclear plants called *fuel on hand* actually is worth more, we should pay more for it, and the answer is no. It actually does not improve resiliency. Quite the contrary. It's interesting that the former East German utility, an ultra-reliable network whose last major supply failure was like 35 years ago, a couple years ago, 49 percent of all its electricity was from renewables and three quarters of that was from decentralized renewables, including solar and wind.

Their CEO said that's not basically because of new technology. He said it's because of changes in mindset. We now understand how to run these systems the way a conductor leads a symphony orchestra. No instrument plays all the time, but the ensemble continuously creates beautiful music. And he said, we can readily go to 70 percent renewables without difficulty, without adding storage. This call for storage and the myth of base load power simply isn't true. Otherwise, you'd do the same for cheap.

VAUGHN: So a lot of these changes we're talking about are at a very systemic level. And I also want to acknowledge another question that came in from one of our supporters—another member of our National Solutions Council. As many of us listen to the news and follow what RMI and other innovative companies are doing, there are many reasons to be positive. But we're also seeing some of the "not so great" news that makes us want to take action on our own. What would we say individuals can do to really help drive toward a clean energy future? What can we recommend to people on this call to help themselves or their friends or neighbors or family deploy their actions and their passions?

KORTENHORST: I would say that as always at RMI, we start at energy efficiency. Just walk through your house and feel the windows and check whether there is cold air or on a warm day hot air coming in through the sides of the window. And if so, it is really even the simplest step to put some insulating tape in it or if you can afford it, replace your windows. Of course the next step is to think about the vehicle that you drive. Is it really an efficient one and are you potentially already considering a plug-in hybrid or even electric vehicle?

It is remarkable how quickly these are becoming cost-effective and how the range is expanding so that you can even start to think about travelling from Boulder, which is the office where I work from, here to Basalt, over the mountains in an EV. Another obvious question is, is it the right moment for you to start thinking about solar panels on your roof?

There is another option that I will mention and it's one that is often forgotten, but that is to think about the carbon footprint associated with your diet. I love a good piece of meat. I can't deny it. But the reality is that if you eat a more flexible diet that has more vegetables and maybe a little bit less red meat, that you significantly reduce the carbon footprint associated with your food. Finally, I will say of course when people ask me what can I do, I can't help but say well, you can go to our website and you can find the page where you can make a contribution. But we'll come back to that later.

VAUGHN: Excellent.

LOVINS: And of course vote your values. And your values are quite diverse. There are many kinds of people listening to this. There's even more in the country. But remember that there are many kinds of outcomes from the energy transition that many kinds of people would like for different reasons. You can get a clean, prosperous, secure future that I think we all want for our kids. You could get better national security, greater competitiveness, strong communities and families, greater community, and individual choice. And you don't have to agree about which of those values is most important. You don't have to agree about climate science or any other particular outcome.

If you like one or more of the many outcomes that the energy transition yields, you could support it. And therefore we focus on outcomes, not just motives because then everybody can play. And we all want the outcome maybe for different reasons. That's fine. We have a diverse society. Diversity is good.

VAUGHN: I think one other exciting aspect is there is never a better time to make your voice heard. There are so many platforms out there with social media and otherwise where people really are becoming active and engaging in very important conversations that shape policy, or shape innovation. And we are excited to tell our supporters that we have launched a new website at RMI.org. And on that landing page you'll notice a take action button, which directs you to what RMI is talking about right now. What are those key conversations that we are taking part in and how can you get involved as well?

So that's another day-to-day action that you can take to make your voice heard. We definitely encourage you to do so.

LOVINS: How do you organize people to do different things? First you talk to one person, then you talk to two people and you talk to their concerns in their language. You talk to them where they're at, not where you're at.

KORTENHORST: Amory, tell us a little bit about some of the work going on at RMI right now that you feel is most exciting. What are some of the projects that you see that people are working on in the organization that get you most excited?

LOVINS: Where to start? Well, I'm just back from Delhi where we helped the prime minister's office as the former planning commission he heads, which is the strategic planning agency in the country, to run a design charrette with very powerful national government and private sector representation, to transform India's mobility. And this is just taking off like a rocket. A lot of the stuff we are recommending and a report that is still at the printer is already happening. They're moving so fast. And this was actually suggested to me a year ago by the energy minister, the same guy whose auction designs made renewables cheaper than coal.

So you have to take this guy very seriously. And he said, can you help me come up with a way to make every two, three, and four-wheeled personal vehicle in India electric by 2030? And he meant old and new, by the way. The level of ambition is just astonishing and we're helping that happen, bringing in best practice from all over.

Then, I mentioned the energy IT mashup. We'll be making an exciting announcement rather soon about ways to harness a wonderful new technology that tells you at any given moment which power plant is just about to turn on if you use more.

So if you have a choice in letting your devices turn on and quite often you do without inconvenience, you could do it in a way that will minimize your carbon emissions and indeed your costs. And this is all done by smart chips. You don't need to actually do anything. But having that information, which comes right off the websites of the grid operators streamed to our energy-using devices, we can give very large benefits to society and we're engaged in the way to make that happen.

Similarly, we're excited about a new technology you may have heard of called blockchain, which enables secure and just about cost-free financial transactions, even at a very small scale.

If you could do things like attach labels to your electricity (which we've never had before) so you'll know where it's coming from as it's being made, you can make smarter choices about what you're using and when. And if you want to do microtransactions or actually let your devices do microtransactions like selling certain capabilities of your electric car to swap power and services with the grid when it's parked, you could do that. The car could do it transparently in the background, securely, at practically no transaction cost. And that, by the way, adds enough value to the grid to pay half the total cost of your electric car.

VAUGHN: And so these are a lot of those ideas really on the bleeding edge. Also, RMI works often at the leading edge.

LOVINS: The same of course with our hallmark work in buildings, and in other ways where we can bring modernization to developing economies. Jules, we're working with new business models in there too.

KORTENHORST: Yeah. Very exciting work going on in our buildings sector where we of course learned a lot of lessons from our own building here in Basalt which is a net-zero energy building. In fact, it's built in the valley of Aspen where it is bloody cold in the winter and nice and warm in the summer, but we just don't have an air conditioning system. We don't have a heating system. So the point being that we have learned the lessons here and we're now rolling out this model, this technology, to other parts of the country.

And we're involved in building projects in the Midwest, building projects in California where we're demonstrating how net-zero buildings or even whole net-zero building, zero-energy districts can transform the way we think about energy in the built environment. Excitingly, that is similarly happening in China. We're engaging with the Chinese government to do that work there as well. In fact, in China, a lot of our work is now centered around implementing the vision that was embedded in Reinventing Fire, the study that we published together with the Chinese government about a year ago.

And the cornerstone for implementation that the Chinese government has identified is cities. They believe that cities are the scaling mechanism, just as we talked about earlier a little bit here in the U.S., that cities are a scaling mechanism. So we're supporting the alliance of priority, teaching cities, cities that are mandated to peak their carbon emissions early, helping them put in place plans that actually reduce significantly their emissions. And then the third portfolio activity that I want to mention because it is so exciting is the work that we do in developing economies.

One of the exciting parts of the agreement reached in Paris a year and a half ago is that it was 195 countries that committed. Not just the rich developed countries, but countries including the poorest like Rwanda and Sierra Leone, the countries at the bottom of the economic pyramid committed to reduce their emissions or limit their emissions growth or switch to a renewable energy system. So we are working in Rwanda. We're working in Sierra Leone. We're working in Uganda. But we're also working with small island nations in the Caribbean and beyond to help them plan the transition to a much more cost-effective and also sustainable energy system.

And because of the dramatic fall in the cost of particularly solar for those countries, we are seeing those solutions not just sustainable, but also economically advantageous for these countries. So that's very exciting.

VAUGHN: And one thing that we're seeing come in from our audience is a set of questions around energy access. One trend that we're seeing is as these developing economies are really trying to provide increased energy access and electricity for their population (like island nations where individual citizens bear an incredibly high cost burden of energy due to imported diesel fuels or how countries in sub-Saharan Africa are trying to develop their infrastructure) they don't necessarily have to follow the same routes that we did in the United States with a large centralized system, and that you can leapfrog that with renewable, more localized minigrids and such.

Can you speak a little bit about how RMI staff and RMI projects are really expanding their horizons in terms of the more personal value proposition that we are providing through our work, through some of our growing international portfolios? I think we've grown about, over 50 percent domestic to international work at the moment.

KORTENHORST: Yeah, so the work on, in the countryside in Africa is a really important illustration. Of course we also look at the centralized energy system in some of these countries. But there is increasingly a recognition that particularly in rural Africa, the right way to provide access to energy is not through the illusion of an electricity grid being extended at some point.

LOVINS: Which you could never afford if it got there.

KORTENHORST: Which would be way unaffordable. Absolutely, Amory. But to put in place a minigrid or a room, a home system that provides electricity in a very cost-effective way.

LOVINS: And of course the key to that efficiency, Berkeley Lab has demonstrated, for example, that with this much solar panel, you can run a 26 inch color television, a very efficient one, a bunch of lights to light up your whole house, a clock radio, a mobile phone charger, and a fan. That's a pretty good start at a decent life. And it's less than half the cost of doing the same thing inefficiently with a lot more solar cells. So again, less capital spreading more benefit to more people a lot faster. And it's not only about electricity. I was just on the phone the other day with the research director for the alliance that does clean cookstoves all over the world, where one and half billion people or so are cooking on wood and dung.

Billions of people per year are dying of resulting lung disease from indoor air pollution and losing their eyesight from smoke and so on. Well, they do terrific work on stoves. I added ten things to work toward on their agenda about developing more efficient pots, which then integrate with the stove. So now we're figuring out how to get that into their agenda worldwide.

KORTENHORST: Let's pause for one minute while we switch our microphones because I hear that our sound quality is quite poor.

VAUGHN: Excellent. While we are switching out our audio, I wanted to acknowledge one question that came in from our audience. And this is from Cliff Kotnik, a member of our National Solutions Council.

He is from Colorado, and he asks about electrification in transportation. Amory, you touched a bit on some of the work we're doing now in India, but he wants to know about physics-based automobile design and as we're encouraging people to think electric when they go to electric vehicles, what are other developments that we can look toward like the latest model of the Chevy Volt and the type of mileage that people can expect to come over the next few years?

LOVINS: Well, this is the year when you start to get roughly 35,000 dollar, 200-plus-mile range electric cars from several vendors. And there's a whole swarm coming after that. Dozens and dozens of models in all shapes and sizes from practically every automaker over the next three years at very competitive prices. They'll probably reach the same sticker price as today's gasoline cars in the early 2020's. And of course long before that, they're cost-effective because they save you so much fuel. Electricity is so much more efficiently used. It ends up a lot cheaper per mile than gasoline.
This is of course most important for fleet vehicles. So if you're using sharing like ZipCar or Getaround, which is software for hiring your neighbor's car when it's parked, or mobility as a service, ride hailing things like Lyft and Uber, or soon autonomous cars, all of those three drive fewer cars a lot more miles and therefore they save so much energy cost that it more than covers any initial higher sticker price. So we'll see this first in fleets. And if we focus support on fleets, we can get 10 times more electric miles than we would get if we just went for helping private vehicles go electric early.

Now of course electrification happens faster and cheaper if you take the obesity out of the car. We now know how to make cars several-fold lighter and more slippery. And in fact RMI has a couple of spinoffs in this area, one of which sold a technology into the supply chain. You can buy it now and it lets you make two by two meter carbon fiber parts in one minute. That's the holy grail. I was just in Detroit a few days ago. There's a lot of excitement in the industry about fit cars, which then need two-thirds fewer batteries.

So they get cheaper a lot sooner and of course they charge faster. So as we gradually make cars fitter, batteries cheaper, down four- or five-fold the last five years, another 70 percent to come in the next few years, and the infrastructure better, I think the electric vehicle revolution is going so fast that even major oil companies are now acknowledging it as a major threat to their business. And the then CFO of Shell said that peak oil in the world, peak oil demand could happen as soon as five years out. They asked him if he wanted to qualify that remark. He said no.

KORTENHORST: And it's also interesting to recognize that this is not just a phenomenon in the developed world. In fact, the largest electric car market is now in China. Not surprisingly. It's the largest car market in the world.

LOVINS: But they sold more of them in 2016 than the world sold in 2014.

KORTENHORST: And some of the other lesser-known electric car companies are actually Chinese companies. So it's not just Tesla. It's not just the major OEMs from Detroit. But it is now a global move. So this is where the acceleration of the pace is a hopeful sign. So many of these transitions are S-curves, are curves where initially the development is slow, but then at some point, you start to see a very rapid acceleration in the very same way that none of us could have imagined 10 years ago that the smartphone would be pretty much standard around the United States.

Initially it was slow and now everybody pretty much owns one. So that rapid increase of deployment is happening in electric vehicles, has definitely happened in LED lighting, is starting to happen in solar, has already happened in wind. So as these curves grow from the slow-moving part to the fast-moving part, in some ways, all bets are off how the industrial landscape is changing. And partly because it's not a standalone thing. All these things happen together. For example, when we think about electric vehicles, it's important to also think about the role that electric vehicles have on the electricity system because you can charge that car at night when you come home, but that time might not be the optimal time.

The optimal time might be during the day at the office because that happens to be the time when solar power is making the marginal cost of electricity very low. So thinking how we integrate electric vehicles into the electricity grid to address the stability issue is another way in which we see that the different trends in the industry are all coming together.

LOVINS: And of course as you have more electric cars, you get abundant cheap batteries, which means distributed solar everywhere. So we've been showing how these batteries, although they are often not the cheapest way to get the benefits, are already cost-effective. That is, their benefits exceed their costs installed in your house in much of the country. It's a very exciting time. And I think what all of these convergent and mutually reinforcing trends show, as Johan Rockström recently remarked, he said, there are kind of two diverging views of the energy future, one built around new processes, new developments, new business models, new technology and design, which behave in the S-curve way that we've seen in hundreds of industries that can grow very fast, especially in combination.

And then another view based on being held back by the inertia of the incumbents. And that way, I think, is looking more and more old and not the way it's really developing. It's not to say those industries aren't powerful or that they don't have important capabilities, some of which society will need. But they need to adapt real fast and that is a huge cultural challenge. You know, as Jack Welch said, "If the rate of change on the outside is greater than the rate of change on the inside, the end is near." These are very large, complex organizations.

So we're very gratified that some of them that we work with are coming over to a different view and making that struggle themselves in how to change to advance the new energy system and not just protect the old one.

KORTENHORST: In fact Amory, you were talking earlier about the Energy Transitions Commission where some of this debate very much played out. And indeed, the accelerating pace of the transition in the electricity system and the ability that gives us to electrify much more of society is very exciting. But it also immediately highlights that we still have a challenge in some parts of the economy where electricity is not the whole answer or not most of the answer. Let me take one example. Cement is currently made out of a process that by its nature emits CO_2. And that is a process that takes very high-intensity heat and therefore cannot easily be electrified.

We'll have to change the cement process, the physical process of making cement to a different process, whether that is based on a complete new technology or based on different fuels, in order to mitigate the emissions in that sector. And there are a few more sectors like that. Amory and I love to have a debate about the viability in the short term of electric or hydrogen-based planes or alternatively a transition in the aviation sector to biofuels. There are still a number of parts of our economy where the pathway to low carbon is not yet crystal clear and where more research work needs to be done, where more analysis needs to be done, where more experiments need to take place, and where we need to in the end accelerate the deployment of the solutions of the future.

LOVINS: To take your cement example, some of those technologies already are entering the market and they need less heat at much lower temperatures. And also of course part of the exciting side effects of cheap renewable electricity like, say, off-peak wind power is you can make hydrogen out of it, which gives you as high a temperature as you want for industrial processes and it's easy to store.

VAUGHN: Right. And now, with about five minutes left here, I want to make sure we address an issue around timing. A lot of questions that are coming in have to do with the race against climate change and to a clean energy future. And really, which one are we going to win? There's a matter of timing. And when we look at a lot of these innovative ideas and projects from Rocky Mountain Institute, in addition to some disruptive technologies that are entering the market, when can we expect to see some of those disruptive projects take hold? Blockchain is one example. Another example that's been brought up by our audience is looking at electrified vehicles versus hydrogen fuel cell vehicles.

LOVINS: Those are all things that we don't need to predict. Nobody does, because they'll all play out in the market. And neither we nor any other analyst, or for that matter bureaucrat, should pick winners. If we create competitive conditions, the best ones are going to win. They'll be different in different places, in different niches. That's good. And that will drive much faster innovation than any choices we can make.

KORTENHORST: But I will say that your question about timing is an important one, right? The urgency and importance of the climate change issue forces us to start thinking about the changes we can make that have real material impact in the very near future. And that is why I'm excited about one program area that was mentioned by one of the questions in the audience, our global methane program. Methane is a greenhouse gas, but it is different from CO_2 in two ways. On the one hand, it increases warming much more significantly.

But on the other hand, it has a much shorter time in the atmosphere than CO_2, so it disappears more quickly. That means that if we can reduce methane emissions, we have more immediate impact. So we are embarking on a program to look to address the methane emissions, particularly in the upstream oil and gas supply chain. And this program might be in some ways tricky and controversial because we have to interact with the oil and gas industry and they're not always as open-minded to those interactions. But on the other hand, they have come to realize increasingly, particularly the European oil and gas companies, that any future role of gas in the energy system is critically dependent on addressing methane leakage.

So working with the oil and gas industry to reduce methane leakage, to reduce flaring where a lot of methane leaks, is a significant opportunity for us and we're ramping up that effort. We're looking to make some significant investments. We're looking for more support because this is one area where we can do something very quickly that can have a real material impact.

LOVINS: It's the fastest way to turn down the global thermostat.

KORTENHORST: Exactly.

VAUGHN: And when we talk about critical dependencies, I think we could not end this call without talking about our critical dependence on our donors and supporters. We are so thankful to Charles Babbs, one of our longtime supporters who has very graciously stepped up and offered a match of 10,000 dollars for anyone that attended this web discussion. So for the next 48 hours, if you decide to support RMI, you can go online to RMI.org/donate and if we receive your donation within the next 48 hours, Charles Babbs will match that up to 10,000 dollars. So thank you so much Charles for your generous support. And before we close, we're right at about time here, I just want to leave an opportunity for any final thoughts first from you Amory and then we'll move to Jules.

LOVINS: We are blessed with some unusually talented and dedicated colleagues. It's such a joy to work with them and with all of you to see what we can do together. It's already exceeded my fondest hopes and I can't even keep up with how fast it's starting to materialize.

KORTENHORST: Let me add to that. Thank you to you Amory. Thirty-five years ago, you had this bold and audacious idea to start an institute here in the Aspen Valley that would influence global energy use to create a clean, prosperous, and secure future. We've come a long way in 35 years. We're going to go a lot further in the next 35. And for that, we're also grateful for all the support that you all on the line are giving us because we couldn't do it without you. Thank you all very much.

VAUGHN: Thank you.