Transcript for #86. Creating Sustainable Transport Energy Options for Everyone
Guest Dr. Amer Amer, Chief Technologist, Aramco
February 13, 2023

Introduction (00:01):

You are listening to Fueling the Future of Transport, hosted by Tammy Klein, the Founder, and CEO of Transport Energy Strategies. We'll talk all about the fuels and energy it takes to keep the world moving forward.

Tammy Klein (00:18):

Hi, everyone. Welcome to the show today. I am so pleased and so excited to have with me Dr. Amer Amer, who is Transport Chief Technologist at Aramco. We're going to talk a whole range of topics in transport energy, sustainability, the energy transition, electric vehicles, the research that's being done at Aramco's R&D centers and I'm just so pleased to have Dr. Amer on the program because he's really a giant in the area of transport energy and transport energy research. Dr. Amer, welcome to the program.

Dr. Amer Amer (00:55):

Thank you, Tammy. It's a great pleasure looking forward to the conversation.

Tammy Klein (00:59):

So, let's get into it. For the listeners who may not be familiar, can you talk about your role at Aramco, and can you talk about your role in creating the company's research centers in the U.S., Europe, and China, what they do, and what drove you to push for that back in the late early aughts around the 2007 time period?

Dr. Amer Amer (01:27):

Yeah, so I guess first of all, transport fuels represent a significant share of the final energy consumption. At the point I was very intrigued by Aramco's proposition. You know, after spending 13 years with the auto industry, really working on engine design and development, I always felt that I'm really looking at one side of the equation. So, when Aramco approached me about an opportunity to establish an effort to address the challenges associated with transport fuels and really try to build a program to improve their sustainability, that was a very intriguing position for me. And really working at the interface between engines and fuels was the major selling point for me. So, upon joining Aramco, I was responsible for the development and implementation of a global strategy and roadmap establishment to position the company as a recognized player in the global debate on transport sustainability.

(02:35):

What that culminated into was the establishment of three global research centers in recognized technology hubs around the world. That's Paris, Detroit, as well as Shanghai. And also involved growing the team capacity and team numbers to address the kind of work that we were going to be involved in. We managed to grow the team from about eight people back in 2007 to about 95 people right now, working with a number of technology providers and automakers, and various stakeholders to really demonstrate the lowest path to reducing the lifecycle CO2 footprint from transport technologies. In my view, over the past 15 years, I think that we have made significant contributions to the science and technology of fuel and engine interactions. The kind of work that I'm managing right now, it's really a large portfolio of research and development projects. And they include company flagship technologies that have strategic significance to the oil and transport industries. And these include efficient power trains all the way to low-carbon synthetic fuels. A very wide portfolio, very wide number of collaborators. Obviously, we realized a long time ago that we cannot do all of this by ourselves so we work with a lot of people around the world to materialize some of those technologies and accelerate their adoption and deployment in the market.

Tammy Klein (04:21):

So, of all the projects, I want to talk to you a little more about sustainability from your perspective. But, when it comes to...I want to touch on research at the labs, as you just said, you have a wide PFO portfolio, low-carbon fuels, synthetic fuels, other types of transport energy technologies. So, in your time since the labs were created, in your view, what's been the most consequential research that has been undertaken at the centers and what stands out to you, the most and will we begin to see the effect of that research into the marketplace?

Dr. Amer Amer (05:12):

I think in general our understanding is there is a role for all technologies to play in terms of delivering on the climate, energy and health concerns that are upon us. From Aramco's standpoint, we started to look at opportunities where we can bring the engine and fuel and optimize them as one system in a very, very synergistic fashion. We also tried to look at some opportunities for technologies that have an immediate impact. Technologies that are in the short term will result in a significant reduction in CO2 emissions. Amongst those technologies that were quite passionate about is a technology that is cost-neutral to the automaker, which is a dilute boost. This is a technology that can deliver up to nine percent lower CO2 emissions on the vehicle front. And, the most interesting part about this, it's not the fact that it's cost neutral and delivers significant CO2, but at the same time, there is no emission degradation as a result of this technology.

(06:22):

This technology is something that can be implemented in the short term. It uses the existing three-way catalyst. And we already have a number of vehicle platforms that are slated for production with an

automaker in the next three to five years. Another technology that we've spent quite a bit of time, and we believe that we've made significant strides on, is the gasoline compression ignition. The gasoline compression ignition technology is, is quite unique in the sense that it offers diesel like efficiencies with substantially lower criteria pollutant emissions. This is an efficient, this is an engine or the it's an engine technology that can achieve 35% lower CO2 emissions compared to a modern turbocharge gasoline engine - that is quite significant. And the fact that it meets significant, or near zero pollutant emissions exceeding US Tier 3 Bin 30 regulations makes it even more intriguing.

(07:29):

The nice thing about this technology as well is that it has the potential to enable significant reduction for the SUV market and you know commercial vehicles, for example, and we are currently looking into opportunities also to work with automakers to see this technology making it in the market. The third technology that we have been putting a lot of effort on is turbulent jet ignition. And this is something that many automakers are currently considering that, in fact, some companies have already put a passive version of this turbulent jet ignition. We are not only looking at passive architecture, but also looking at active turbulent jet ignition architectures and designs that will deliver even more CO2 emissions. We talk about engine technologies, but at the same time, we are very intent on looking on the criteria, pollutant emissions.

(08:30):

And we have developed a significant number of technologies that result in significant reductions in criteria pollute and emissions for the light duty. We've managed to some of the work that we have done we managed to demonstrate 90% lower NOx emissions, but also significant reduction approaching that number on hydrocarbon nitrogen oxides, as well as particulate matter. Those technologies are very much needed because the automakers would have to meet the future emission regulations, which are becoming increasingly more stringent. We've also worked on the heavy duty side of the equation, and we've also realizing that 70 to 90% of NOx reduction is expected in many markets around the world, including the U.S. and Europe, for example. And we within Aramco have developed a new combustion process which we paired with an optimized engine system, advanced control and new catalyst system can really deliver significant production in NOx emission.

(09:38):

This is the biggest challenge for the heavy duty sector. One of the intriguing outcomes is that on a hot FTP certification cycle, we have achieved more than six times lower NOx emission levels. This is related or relevant or relative to the latest California or CARB regulations. Essentially, beyond that, we have also looked into mobile carbon capture, which is a technology that many people have looked at as a far-fetched idea, but certainly it's a technology that we have spent quite a bit of time on. We've developed a number of generations on this vehicle. So we've developed the system to capture CO2 coming out of the exhaust system combined that with the entire part of the capture system where it's compressed and

stored onboard the vehicle. And following the multiple generations of vehicles that we've demonstrated, and the understanding that we've gained over the year on this technology, we've realized that it truly has a very good fit for marine applications.

(10:45):

This is because the issue is not about the CO2 capture. This is a technology that people can do today. It's about the infrastructure in terms of how do you deal with CO2 once you capture it onboard the vehicle. And the marine applications really offer for an opportunity where you can leverage existing bunkering infrastructure, which can be used to offload that CO2. And that is one of the propositions that we've started now to develop a lot of effort working with a lot of players out there, including the oil and gas climate initiative, which brings a significant number of energy companies together with the intent to have a significant reduction or developing technologies that will result in significant reduction in CO2 emissions.

Tammy Klein (11:39):

Yeah, that's really interesting. I know about mobile carbon capture and the activities, the research that are ongoing at the labs, but I had no idea and it's certainly not common knowledge, I think in many spots, that this could really be useful, and actually it could really be transformative for shipping. It's a hard-to-decarbonize sector. I mean, there's lots of discussion about methanol and ammonia, and they really have their biofuels, and they all have their pluses and minuses. But I think the reality is that it's going to be tough to decarbonize. So that really presents kind of an interesting option.

Dr. Amer Amer (12:33):

Yeah, absolutely. And particularly because of the fact that the CO2 avoidance potential there is very high. It could be beyond 50%. And this depends on essentially how much fuel you want to use, because you need some of the energy you need to harvest some of the energy to actually enable, we will capture system. So you can go very high in terms of CO2, as you know, avoidance. And ultimately, it comes to a question at the tradeoff, essentially. And ultimately you have to look at it from a CO2 abatement cost standpoint. But certainly, the potential is very high. We've demonstrated about 40% today on a class A truck in our facility in Detroit, which, where we were able to do that onboard that truck, and store that CO2 onboard that truck.

Tammy Klein (13:26):

So, I want to go back to something that you were talking about earlier. The emphasis and burgeoning focus on sustainability. So, there's, I mean, let's be honest, there is skepticism, a high degree in some cases that oil companies will have any role at all to play in decarbonization that includes transport and transport energies. So how, in your view, how do oil companies counter and respond to this skepticism? And what role should they play? I mean, what is the Aramco vision for decarbonization? And then I want

to ask you a little bit more in depth on topics like electric vehicles and other technologies. But what do you say to all of that?

Dr. Amer Amer (14:26):

I think in short, we need all hands on deck. And I think demonizing one industry or excluding one industry is not helpful. I think everybody needs to come to the table. All stakeholders need to work together to really end up with you know, a resilient and lasting impact on CO2 emissions. We all know that we are facing a dual challenge here. We need more transport energy with less emissions. In fact, we need more energy with less emissions in general. The question is, how do you get there? And, there's a lot of people who have proposed silver bullet solutions, and many of those solutions, in my view, they come without full consideration of the unintended consequences. And this is mainly because, or result in improper accounting of greenhouse gas emissions. In a nutshell, you're moving the burden or shifting the burden from one sector to the other. So, in reality, all energy sources will be needed to support a successful transition in the future.

Tammy Klein (15:39):

I call it moving the coconuts around, you know...

Dr. Amer Amer (15:45):

And, in general, I think energy companies are a major stock stakeholder in the entire energy transition and decarbonization. And they need to be part of the solution. And in fact there is significant number of energy companies that have committed to lowering their scope one and two emissions, including Aramco, where we aim to achieve net zero scope one and scope two greenhouse gas emissions by 2050. And we're looking into a wide range of opportunities to achieve that, which includes energy efficiency measure. We're looking into deployment of carbon capture utilization and sequestration hops. We're also looking into increased share of renewables as well as offsetting through systems like direct air capture into the future. All of this will contribute to addressing the CO2 once. One thing that we need to keep in mind is that when we talk about CO2 emissions, we have to understand and appreciate the fact that we are not only concerned by the new emissions that will be generated from today, but we're also concern concerned with the emissions that already exist in the atmosphere.

(17:00):

So, solutions that will address only one part of the equation does not give a resilient impact and a lasting impact on greenhouse gas emissions. Our intent together as a community and the world, we need to address CO2 emissions. How do we do that? And who does that? I think everybody needs to come to the table. We need all hands on deck, and we need to welcome all contributions from all stakeholders so long as they deliver on reducing CO2 emissions and addressing the climate challenge, which is our collective interest here.

Tammy Klein (17:39):

So you already talked a little bit about this, but you talked about the research at the centers. But what I want to know is, if we look at the big picture and we look at the globe, what are the most promising technologies and strategies in your view to decarbonize fuels and vehicles in the coming years? You mentioned one - carbon capture and storage. But is it going to be...you talked about lower carbon fuels. Will it eventually be synthetic fuels, fuels like electro fuels or power to X? Will it be hydrogen? We touched on ammonia and methanol for shipping, how do you see it in your view?

Dr. Amer Amer (18:28):

Honestly, I really think that the answer is really all the above.

Tammy Klein (18:33):

Yeah.

Dr. Amer Amer (18:33):

For us to really end up with a significant impact on greenhouse gas emissions, the right technology choice must be adopted in the right sector at the right time to make sure that you have the biggest impact. Picking winners and losers early on in the game doesn't help us. Synthetic fuels will play a role. Electric vehicles will play a role. Gas will play a role. All of these vectors, energy vectors will play a role in the future. The only thing that we have to be cognizant about is where do we apply them and how do we apply them? Because if you focus, which is what many have been focusing on to reduce the greenhouse gas emissions to address only the electricity sector, as well as the light duty vehicle sector through electrification.

(19:30):

Now, let's look at this very carefully. You know, when we look at electricity, it's, it's really electricity greenhouse gas emissions. They contribute about 25%, give or take to the total global to the global greenhouse gas emissions. The light duty vehicle sectors contribute about eight. So, if you limit your actions to those two you basically are addressing only a third of a group of the total greenhouse gas solutions. There needs to be other energy factors. Biofuels will also contribute to the equation and will be part of the solution. The only thing is that there is no one solution. It's a portfolio of solutions that will result in addressing this global challenge. So if we take a step back and we start looking, for example, at synthetic fuel, synthetic fuel is something that Aramco has been putting a lot of effort behind recently.

(20:26):

The way we look at synthetic fuel is that we think that it's a broad class of hydrocarbon fuels that are chemically synthesized and usually from hydrogen and CO2. Some people use Power to X or electro fuels to define those. From our standpoint, we're specifically interested in low-carbon synthetic fuels, which combine low-carbon hydrogen that is produced from renewable electricity with CO2. And of course, CO2 in our view could be either captured directly from air or from industrial installations. Now, this fuel whether it's liquid or gas it can be engineered to be chemically similar to conventional fuels in the market, a true drop-in solutions. What this means is that it can use the existing vehicles and fueling infrastructure and thereby support a more seamless and organized energy transition in the future. Within Aramco, we have plans to erect demonstration plans, and we plan to have those in operation as early as '25. And we believe that a greenhouse gas reduction on the order of 80% on a full life sale cycle basis relative to conventional fuel is possible. This is quite significant.

Tammy Klein (21:57):

Oh!

Dr. Amer Amer (21:57):

Yeah. The fact that they are truly drop in and they're designed on a clean sheet of paper so you could potentially design fuels that could have an added value proposition along the lines of improving their criteria emission profile as well. One of those plants that we have planned for is going to be in Spain. And it targets the production of low carbon jet and diesel fuel, as well as NAPA. And, this technology uses reverse water, gas shift, and Fischer–Tropsch technologies. And usually these kind of units are followed by hydrocracking and product upgrade units. We also have another plan here in Saudi Arabia. This is a bit more interesting because first of all, it's aiming at producing low carbon gasoline fuel using direct methanol synthesis, followed by methanol to gasoline technology, and of course, with some upgrade unit. The intriguing or the interesting part about this pilot plant is the fact that it's a double plant that it will leverage the Kingdom's high cost competitive, renewable solar and energy. You know, the Kingdom has unmatched combined capacity factor for solar and energy. Ultimately, potentially demonstrating the lowest cost of these kinds of fuels in the future.

Tammy Klein (23:27):

But also, you've got all the land and all the ability, of course, in the world to do this.

Dr. Amer Amer (23:33):

It's pretty amazing in addition to that. So it's the ability, it's the land, it's the fact that you have solar energy and you have wind energy, but also you have abundant and cheap zero two sources, and you already have a vast supply infrastructure that you've used for many years already that can be leveraged

for that. So ultimately, this particular setup could demonstrate the lowest cost synthetic fuel that can be used in the future. Now, back to your earlier question about which factor - is it gasoline? Is it diesel? Is it methanol? Is it the way we look at these demo plants is that deals are really test platforms for us? We're trying to understand the entire value chain, and we are trying to understand what is the best way and the most cost effective, and the easiest way to move molecules around the world.

(24:28):

And our commercial plant will be based, will basically build on the learnings that we'll gain over the coming few years out of these demo plants, and will help us decide on the construct of this commercialization effort that we will have in Kingdom on this front. Hydrogen is also the same - another molecule that has great potential. Of course, hydrogen can be used in many different ways. Hydrogen can be used directly in fuel cells, and also hydrogen can be used in an internal combustion engine. You know, there are companies that have been looking into opportunities to develop you know, fuel agnostic engines that can use a wide range of liquid and gaseous fuels, including hydrogen. The nice thing about hydrogen compared to fuel cell is the purity aspect, because it doesn't have to be, doesn't have to have the same purity that is required for a fuel cell application. And with this hydrogen you can think of it as an opportunity to catalyze the, the demand for hydrogen until other alternative technologies reach maturity. And with that time, you are gaining time, you already are contributing to reducing the greenhouse gas emissions. So you're not waiting for the technologies to mature, for the infrastructure to be there and for the cost to come down. You're doing something today that will have a lasting impact and prepare us for a future where the alternative technology will play an increasing role in addressing the global greenhouse gas emissions.

Tammy Klein (26:08):

And it'll allow the Kingdom to shift over time as well. As these new sources and new technologies are developed and become commercialized pivoting.

Dr. Amer Amer (26:20):

Yeah, I think the company really has a very wide portfolio that involves you know different markets as well on different technologies. We believe in technology neutrality. We believe that different parts of the worlds will have different needs. And we are looking into opportunities that will satisfy the energy needs that are coming from all the world. We're not trying to limit our ourselves to one side of the world.

Tammy Klein (26:52):

So, it seems like, to take two slices of the world, it seems like in North America and Europe, the approach from a policy and market standpoint is really focused heavily on electrification. And increasingly the phase out of the internal combustion engine vehicle, which I never thought I would

really see in the U.S. But now we have a program in California that is going to be adopted in many states that requires basically the phase out of the internal combustion engine vehicle by 2035. We know a bunch of countries are following. So what are your views on such a strategy and where does the car ban, ICEP phase out slash electrification strategy leave Aramco, but more importantly, the rest of the world? Because I've worked all over the world and I don't see many countries outside of the west being able, at least at this time, to really kind of follow that pathway. So where does that leave them?

Dr. Amer Amer (28:09):

Yeah, that's a very interesting question. And I think it boils down to looking at emerging and developing markets. And those will have...we cannot have the same solutions for those two markets. So, in my view, for many emerging markets efficient internal combustion engines dedicated hybrid-type combustion engines with very low or near zero criteria, pollutant emissions that potentially could work on synthetic fuels in the future will create a very good value proposition. Because the focus there is really on affordability and lower criteria pollution emissions. And, this essentially will help with creating more sustainable transport on those parts of the world. Now, if you look into more developed regions where electric vehicles have started to penetrate the market, it may still take decades for the existing vehicles in the fleet to be completely renewed, takes about 10 to 12 years, depending on the market for the fleet renewal.

(29:20):

So by leveraging the existing fuel manufacturing and supply infrastructure and existing vehicle fleet drop in low carbon synthetic fuels can enable a faster fleet demonstration in the next few years. This is an immediate solution. So, let's take India for example. You know, and we've done a paper recently that we published in Nature Communications, and India's power sector is still heavily dependent on coal. Now, without a clear trajectory to decarbonize the power sector in that country, there is a risk that eds may actually increase the overall CO2 emissions. Some people may not expect that, but this will likely happen given that heavy dependence on coal for power generation. So in that scenario, you're really shifting the focus or shifting the burden from one sector to the other, you're not really addressing the CO2 challenge.

(30:22):

And all analysis really pointed to that and pointed to the fact that you know, very efficient hybrid and low criteria pollutant emissions type of engines will have a big role in the mid to short term. Now, of course, we know breakthroughs in battery chemistry and technology will be important to drive the future improvement in both not, only clones, but all costs. But also cost and also the development and deployment of fast chargers are needed. And that would, that could, enable frequent fast charging opportunities and this will potentially reduce the battery range requirements essentially. So in a nutshell, and to me, hybrid technologies with varying electrification level and battery sizes will be key for countries like India. Hybrid vehicles are efficient, low emission, low emitting, and they do not require

an additional infrastructure that we have to establish. And, since they already have smaller battery sizes, they will also be less demanding on our limited battery capacities worldwide. So all in all they will deliver as I always try to refer to immediate impact on greenhouse gas emission.

Tammy Klein (31:52):

So we talked a little bit about transport sustainability, but what does, in your view, what does, and I think we're talking about this a little bit, that it's going to look a little bit different depending on where you are in the world, but, what does, if we assume we're in an energy transition what does a sustainable energy transition look like? And the reason I'm asking that is, as an analyst and advisor, one thing that I really see is these policies that we were just talking about electrification phase out. There's, but there's no overarching, and there may be other policies respecting hydrogen - a lot of countries want to get into the hydrogen business now - there's battery manufacturing that's really taking off here because the policy is demanding it. We're talking sustainable aviation fuel, other low carbon fuels, but there's no sort of overarching roadmap in many places about what a sustainable energy transition looks like. And I think we're seeing, yes, we have some issues in Ukraine and what's going on there, but I think we're seeing a little bit of this right now with energy prices and what's happening in Europe so what does a sustainable energy transition look like in your view, sort of knowing all of this?

Dr. Amer Amer (33:33):

Another very, very interesting question. I think maybe there is a couple fronts for that. First of all, we really need to have consensus around the essential oil and gas with lower emissions. So the role that the energy companies are going to reduce their greenhouse gas emissions is, is quite significant. And this is going to be working side by side with alternatives to meet rising global demand on energy, and at the same time deliver on the net zero ambitions that we have. So that's one front in my view. The other front is that the fact that the world really needs to embrace new uses for hydrocarbons, and these are along the lines of blue hydrogen. And I think to me we should be colored blind when it comes to hydrogen and other oil energy carriers and technologies, and we need to focus on technologies that capture and sequester carbon. Looking into technologies like direct air capture, which has significant potential to deliver very meaningful you know, CO2 abatement costs. And in my view, without these approaches, it will be very difficult to reach the net zero. And I think there is a lot of think tanks and a lot of people have been calling for the multi-pronged approach when it comes to addressing this energy sustainability into and addressing the net zero emissions, which basically talks about new energy talks about neutrality and making sure that we don't pick winners or losers, but ultimately allowing all for all technology to be developed at the same pace, and ultimately giving them the opportunity to compete on a level playing field.

(35:33):

And the market dynamics will ultimately pick what is required. So looking at all energy vectors, whether, whether it's coming from bio sources, comes from electricity, comes from oil and gas energy you know,

powertrain technologies that are electrified full electric vehicles, fuel cell vehicles, and either other novel powertrain technologies should be allowed to compete on a cost CO2 reduction potential, ultimately, and the market will pick those fuels. In the future, you probably are going to see fuels that are going to be different from one sector to the other. You know whether it's the marine sector, sustainable aviation fuels that you alluded to that could potentially come not only from you know, bio-based, but also from electro fuels, methanol, ammonia could actually play a big role in marine sector. And other applications synthetic fuels different technologies will across the road sector also could have a role to play in various markets. So, it's not...I don't think the answer is very simple, given the diversity that we have and the different needs that we have from different parts of the world.

Tammy Klein (36:57):

So, fun and last - not that the other questions weren't - fun and last question. What excites you most about this space and why? You've worked in the space over 25 years? What's the most exciting? What gets you/keeps you going?

Dr. Amer Amer (37:15):

I think what keeps me going is a couple of things. The magnitude and the pace that is currently taking place to address this climate challenge. I think the fact that the transport, as well as the energy industries are having to reinvent themselves to address these challenges is quite intriguing to me. And what keeps me really keeps me enthused is the fact that I'm able to contribute to this picture and to this evolving and very dynamic picture is very intriguing and very exciting to me. And I hope a lot of people and the young generation also see it that way. And we can get more brains to contribute to the evolution and to this evolving story over time.

Tammy Klein (38:07):

Well, Dr. Amer, thank you so much for being on the show today. It's been a real pleasure to talk with you.

Dr. Amer Amer (38:14):

Thank you very much. It's been a great pleasure. Thank you very much.

Closing (38:23):

You've been listening to Fueling the Future of Transport. This show is hosted and edited by Tammy Klein, produced by Carolyn Schnare, and engineered by Aleksander Nicolich. To hear more great episodes of this show, learn more and sign up for a free biweekly newsletter, visit transportenergystrategies.com.