Investing in Sustainable Aviation Fuel

nfpResearch and Climate Catalyst
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Table of contents

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Who we spoke to / methodology

- nfpResearch carried out 17 in-depth interviews with venture capitalists, institutional investors, lawyers and insurance brokers working in the sustainable aviation field. The VCs worked for firms investing in a broad range of sectors, including but not limited to: decarbonisation, synthetic biology, aerospace, construction, energy and industrial innovation and climate tech.
- Interviews took place between 22nd February and 15th May 2024. All interviews were conducted on Teams or Zoom.
- In total we contacted 124 firms and often contacted multiple members of each organisation with a role relevant to this topic. We had 9 responses declining our interview invitation.
- We offered a £100 donation to a charity of their choice as a thank you, and interviewees chose charities related to sustainability or to personal matters.
- The findings laid out in this report represent a snapshot of how investors currently perceive sustainable aviation fuel, and do not represent the views of nfpResearch or Climate Catalyst.

Sector	Job Title	Geography
Venture capital	Partner	Europe
Institutional investment	Managing Director	US
Law	Partner – Transportation finance team	Europe
Venture capital	Partner	Southeast Asia
Venture capital	Managing Partner	US
Venture capital	Operating partner	US
Insurance	Director – Climate Risk and Resilience	Canada
Law	Partner – International climate finance	Europe
Venture capital	Director – Governance and Sustainable Investing	Europe
Public / private consortium for alternative fuels	Executive Director	US
Venture capital	Investment Principal	US
Institutional investment	Manager – Sustainability and Responsible investment	UK
Venture capital	Partner – Head of Capital Markets and Investor Relations	US
Venture capital	VP of Research and Strategy, and Investment Associate	US
Venture capital	Partner	US
Institutional investment	Principal Consultant	Australia
Institutional investment	Vice President, Global Client Solutions	UK

Key findings

1. There is little optimism among investors that aviation will be net zero by 2050. There have been some positive steps with regulation in the EU and US, but more is needed to accelerate progress. It is not yet clear what aviation will look like in 2050, whether it be short haul electric planes, hydrogen powered flights or a combination of SAF and carbon off-setting. In general though, SAF is seen as an important short-term solution.
2. The investors we interviewed have a good understanding of the different types of SAF, differentiating between bio and synthetic fuels. Most investors very quickly highlight the limitations of current SAF production methods and the difficulty in scaling SAF – because of insufficient feedstocks, green electricity or costs of production.
3. The major barrier to SAF investment is uncertainty around a return on investment. Other barriers include:
    - SAF is expensive to produce and costs more than kerosene. Airlines cannot afford to pay significantly more for fuel – some investors spoke of airlines as not creditworthy and off-take agreements having ‘no teeth’.
    - Institutional investors are cautious and do not appear to be actively considering investments in SAF.
    - The oil and gas sector is conspicuous in their absence in this space, and is currently perceived to be investing in carbon sequestration.
    - Insurance companies are not yet adept at insuring new technologies, including SAF.
    - Regulations and incentives have made a significant impact, and mean the industry could become ‘very profitable’, but the lack of big investment for scaling means the industry is being held back.

Key findings

4. Mandates and policy interventions are essential in building the SAF market. ReFuel EU in particular has built confidence in the long-term viability of SAF. Investors also noted and praised the US approach of incentives to boost production, though on balance Europe's approach is more impactful. One lawyer highlighted that if governments stated what the penalty for non-compliance of phase 1 of CORSIA was, this would speed up aviation's path to decarbonisation (and likely adoption of SAF).

5. Investors referenced a very wide range of information sources they go to about SAF and other new technologies. Some information gaps were highlighted –total off-take commitment from airlines, testing the assumptions of the models of SAF producers, and guidance on what level of policy intervention is required to achieve a higher usage of SAF. But ultimately, investors want to speak directly to SAF companies, understand their model, their plans for growth, and test this with fellow investors.

6. When asked about what role NGOs can play in boosting the production and adoption of SAF, many investors see a role in influencing policy makers to provide the carrot and stick of mandates and incentives. A handful want NGOs to be less critical of the commitments airlines and companies are making towards decarbonisation – a belief that ultimately policy has failed in this area and so we need to be more encouraging of voluntary action. One or two investors also pointed to very wealthy foundations making large commitments in the climate and SAF space.

01

Aviation in 2050

Where will aviation be in 2050?

Summary of aviation’s progress to net zero

- Investors believe that progress is currently far too slow to reach net zero by 2050, and that the goals are there but are being rolled back. There are good intentions, but the reality is that supply is not there. Cost is high, and one interviewee stated that currently SAF represents 0.1% of fuel consumption in the US, so there is a very long way left to go.
- However, there is some positivity and hope around policy, incentives, and a mix of solutions which could start to bring down aviation's carbon emissions by 2050 - even if net zero is not reached by then. As an example of progress, one investor referenced the ‘moonshot goal’ in the US where SAF would make up 10% of all aircraft fuel consumption by 2030.
- Interviewees point to a mix of solutions rather than one clear path to follow. This includes biofuels and synthetic fuels, battery power and technological improvements. A couple of interviewees mentioned flying less. Many also placed their hopes on policy regulations and incentives to lower the cost of producing SAF, and some mentioned reducing the volume consumed. No one mentioned that the price of kerosene would have to increase.
- There is sense that progress will happen very quickly when it does (‘it will all happen in the last 5 years’). Some suggest that current incremental efforts will catalyse into significant improvements once the markets are more mature. As more money is poured into SAF, production will become more standardised, saleable and economically viable.
- Others are less optimistic about SAF scaling up fast enough and see carbon finance / offsetting as crucial to meeting net zero targets. However, carbon offsetting is also severely underdeveloped.

Progress in the sector is too slow to reach net zero by 2050, even if there are good intentions

“This is kind of a broader point about everybody having set goals for 2050 and gradually rolling those back, almost across the board, and I don't think that these [aviation net zero goals] are immune to that. So I would say yes on intention. And there's a lot of really good intentions to go do this. (…) but probably no in reality. And I think the reason for that is just the supply side. There are so many issues related to what has to happen on the supply side for folks to get there and the demand side has got to play its role in making that happen.”

Venture Capitalist, US

“No, and a number of organisations have done great work on this, the IEA and Rhodium group and Bloomberg Energy Finance come to mind. Candidly, I haven't looked at their latest forecasts, but my understanding is that SAF utilisation is well under .1% of total fuel consumption in the US. It's probably a little bit further ahead in Europe given the regulations there. So we're starting from the baseline of 0 and at the same time demand for aviation is of course accelerating which is a great thing, but the challenges of scaling up SAF supply are significant.”

Venture Capitalist, US

“No. It's just gonna be too difficult. I hope I'm wrong. Mostly like the reasons for every other industry. Cost. Business firstly [has] to make money, that's why they exist. That's why their shareholders invest in them and that's what the board expects from them and while doing the right thing is important for them to stay in business. First, it's about making money, and right now the solutions are just too expensive.”

Venture Capitalist, US

No clear path, but lots of different solutions will be needed

“The solution to decarbonising aviation will be multi - I think there'll be some biofuels. There'll be some e-fuels. I think e-fuels will be small just because of the costs associated with it. And I'd rather use those electrons for other purposes than making fuel. I just think it's a stupid way to make fuels. And there'll be offsets. I think it'll be a combination of that. What I'd like to see, I don't think it's realistic, but the other thing I'd like to see, the thing you didn't ask, is use less, fly less.”

Venture Capitalist, US

“*I can't point to anything right now that's the city on the hill, that’s really representative of the success that we expect to spread like wildfire across the sector. (…) We're actually at a unique opportunity or unique period in time right now where the enormity is starting to sink in with some folks and the airlines here in the US. (…) I understand that [complexity] is an impediment. But I also understand that that is likely one of the criteria that will ultimately spell success for our industry. Because other than CO2, there are no ubiquitous sources of feedstocks around the world, and aviation is a worldwide enterprise.”*

US, public / private consortium

“I'm optimistic that there will be a mix come 2050. There will be a mix of aircraft, some operating whole battery power and there may be some hydrogen but same as with the fuels that the demand, the hydrogen and power to create hydrogen is going to be difficult. There will be technological improvement. I desperately hope that it's on the timescale […] but that SAF and offsets will be the only way that we get to net zero.”

Lawyer, Europe

Policy and incentives necessary to help with reducing volume and cost of SAF

“I’ve become slightly more optimistic about long term prospects as a result of recent regulatory changes. The US Biden administration has done quite a lot. It's great that we now have the moonshot goal to get to 10 plus percent by 2030. And I think there's also a DOE earth shot initiative to lower the price of SAF significantly.”

Venture Capitalist, US

“Yeah. So definitely SAF, and ultimately policy is going be a huge thing in the first instance. The trouble is I don't think you're ever, through policy, going to stop people from flying. We’ve seen it various times through history. You saw it at 9/11, you saw it during COVID. When people are practically forced to stop flying, they will come back in the end. […] I think that's the two ways that you do it, right? You reduce the volume and then you decarbonise. The volume side is going to be really, really hard to hit.”

Institutional Investor, UK

“It'll either have to be through force - regulation - or the solutions being economically viable so that they can stay in business and people will keep paying the airfares that they would have to pay for the abatements. I think both will happen.”

Venture Capitalist, US

Some see the current efforts catalysing into significant change as 2050 draws closer and the market matures

"It's such a multi layered question. By any metric the answer is no. But like many things in technology, there are little incremental tiny improvements over time. And then all of a sudden, it's like a right angle and everybody is like, 'OK, we have to do it now' and then it turns on, right? I believe, as human beings, we're very good at emergencies and we're not so good at long term planning. I'm pretty optimistic, I'd say 70/30, we're hitting that [2050 goal], but only by making substantial demonstrable progress in the last 5 to 7 years. We will see smaller incremental improvements in the interim, which is not the right thing to do."

Venture Capitalist, US

"I think most countries and most industries aren't really on track to be by 2050. I think everyone has goals and visions and there's certainly a lot of innovation in the space that if it would catalyse in the right way, could get us there. I think the key drivers are technology and the economics of those technologies. At the end of the day, solar power today is at the scale that it is not because of how people believe it's clean – it's because it happens to be the most economic source. And similarly, I think with the right incentives, if we can get clean fuels to kind of that market position, we'll start to have a real impact in pushing dirtier traditional aviation fuel off the market."

Venture Capitalist, US

"I think that what will help will be a homogenisation of the way that SAF is produced that will settle into the industry. We're in a period now where there's a lot of improvisation and people are looking to distinguish themselves as SAF developers by having a particular feedstock conversion technology pathway, along with a particular geography (…) and the more that gets developed, the more it evolves and matures, the more people will realise what are the most economic ways to make SAF for different countries and then it's going to be much easier."

Institutional Investor, US

Investors have mixed views on carbon capture and offsetting, but agree finance is currently low

"SAF is just not going to make a dent in anything from a climate perspective for […] two decades or really before it's anything close to what it needs to be scaled to. So there needs to be carbon finance. Desperately. We need to mitigate and compensate for emissions this decade."

Lawyer, Europe

"The thing for aviation, because it's so hard to abate, is to do high quality carbon offsets. So carbon capture and sequestration. We think that's much lower cost, much more scalable, a much more viable solution."

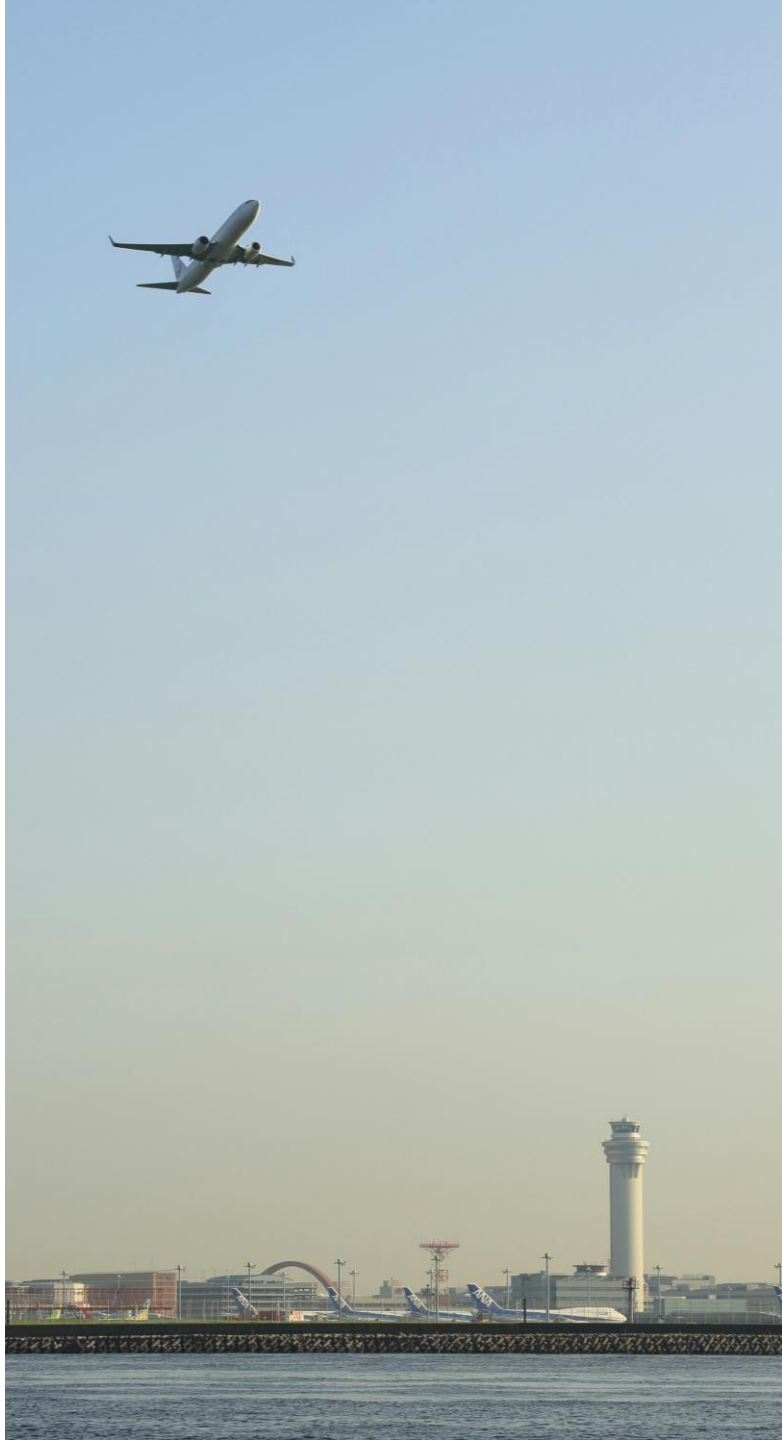
Venture Capitalist, US

"Effectively we're putting a price on abated carbon emissions. That's what we need to do and that's happening around the world, but it's not happening quickly enough. In the context of aviation, it needs to happen for several reasons. The obvious one is that it's absolutely the right thing to do because there is no short to medium term pathway to decarbonising aviation because SAF just doesn't exist. […] There are almost none of those projects in the world. There are less than 10. And you have to remember that they're needed not just for aviation. They're needed for global North countries to meet their emissions, and corporates now want them to the extent that there is corporate appetite."

Lawyer, Europe

"I personally have zero faith, less than zero faith in the carbon offset industry and in how that's done. You read headlines like the other day where it was, who was it? Was it Shell? Or maybe it was mining companies? Who'd earned money for twice as many carbon offsets versus the actual carbon that they had captured. I think it was Shell. It was in the FT a couple of weeks ago."

Institutional Investor, UK



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Perception and understanding of SAF

Summary of perceptions and understanding of SAF (i)

- The venture capitalists who took part in the research were generally investing in innovative technologies in the spaces of energy, transport, infrastructure amongst others, and some were already investing in SAF. Some had scientific qualifications and they often had a detailed knowledge of the different types of SAF and their production processes. Institutional investors and adjacent industries, such as insurance and law, had a slightly less in-depth understanding, though again were generally aware of the different types of SAF.
- Investors generally felt there was sufficient information available about SAF production, or if they didn't know much about SAF, felt like they could access the information. But as we discuss in the next section, return on investment is the main barrier for the majority of investors, not lack of information. The technology being sustainable is almost just a bonus. VCs who have invested understand the process of producing SAF, but scaling up and reaching the public markets will be the real test.
- The SAF market is seen to have a high number of start-ups with a noticeable absence of big players. One investor held the view that most SAF investors are strategic – in it for the new technology – rather than financial, suggesting we're '5 – 10 years away from scaling'.
- Regional differences in resources, legislation and policy shape what type of SAF can be produced and what kind of environmental impact it will have. Investors in the US and Southeast Asia mention the EU as a place where policy allows for a more developed SAF market. There is the perception that policy is shaping demand and allowing for lower costs.

Summary of perceptions and understanding of SAF (ii)

- When discussing SAF, discussions quickly veered towards the limitations of different methods of producing the fuel. We have organised these in terms of biofuels first, and then e-fuels, as these are newer and lead to wider discussions about green electricity use. Either way, one of the baselines is how resource-intensive producing aviation fuel is, and how hard that is to align with sustainability goals.
- Investors are aware that biofuels use large amounts of biological materials, which can have an adverse impacts - deforestation, decreasing food supply, the high carbon footprint of growing crops. The idea of using waste as a feedstock for biofuel at scale is seen as an unrealistic solution - there just isn't enough waste for the volume of aviation fuel needed.
- Power-to-Liquid fuels would be the best way to reduce emissions for some - but many investors highlighted that the process is very complicated: finding the right CO2 and electricity as feedstock, at the right price. They mention how hard it is for PtL to be economically viable.
- Some of the more environmentally engaged investors and lawyers we spoke to questioned whether SAF made sense in terms of sustainability at all. Fuel blends mean there are still very high emissions to flying. One thought the best path to decarbonising aviation was not developing e-fuels, but simply using as much biofuels as possible without harming the environment, burning kerosene and then using direct air capture (extracting CO2 from the atmosphere directly). Many highlighted the increasing demand for green electricity – for the grid, households, businesses – and that using it for aviation is inefficient in a world where demand is higher than supply. Some posed this as a question, while a couple of respondents were adamant green electricity should not be used for aviation at all, and that no one should be investing in the e-fuel market if the overall goal is net zero.

People that are really into this space really do understand it. And there is at this point in time, a very deep understanding of the limitations and the cost implications as well. But it's a narrow set of players. These are very high-powered investors, very sophisticated ones that really do understand both the demand side considerations as well as the supply side cost. I think the real test will come when some of these go to into public markets, which will need to happen in the next one to three years. There, I think it's going to be more challenging for the broader market to understand these solutions so that they don't get done on speculation, but on the other hand don't get into mad cycles of ups and downs as they're trying to really scale up.

Venture Capitalist, US

Understanding not perceived to be a barrier for investors, but scalability is

“I think that they [investors] have educated themselves enough that they know there are different sources of feedstocks, that it is geographical, certain ones are obviously ahead of others at the moment and that the limited source of feedstocks requires variety. I think if you asked most people to explain how it works […] the actual science of it is probably more complicated but I don't see that as being a barrier and I think that there's also an understanding of not having your eggs all in one basket on that front.”

Law, Europe

“[on benefits of e-fuels over biofuels] I think there's a lack of understanding […] I think they're probably broadly aware that there are more sustainability related benefits from them. I don't think it matters to investors because they care about ‘am I going to get stuff produced in time and is the mandate gonna be there that requires that it gets purchased?’ I think that there's a lack of understanding within the industry about the problems of sourcing. […] I don't think they care that there's more sustainability […] They may theoretically or personally be saying: ‘yes, I think e-fuels are better because they are more sustainable’. But the thing that matters is getting it over the line internally ,whether they can show that there will be production”

Law, Europe

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Bigger players like institutional investors tend to be less knowledgeable

"Honestly, I heard about SAF for the first time at the back end of last year. So not well understood. And probably a big lack of understanding as to how green is green. How decarbonised are you? How much of an impact are you actually able to have? Coupled with is it equally efficient? Does it work equally well? Do the planes go as far? What kind of bang for your buck are you getting? […] we run some case studies that we do on SAF in trying to educate and help our investors to understand the journey that we're on from a sustainability point of view. And I would say in terms of the different types of SAF, (…) literally zero understanding. I mean, in the same way that people up until very recently didn't even know there were different types of hydrogen and, you know, different levels of not just hydrogen but actually hydrogen enriched fuels. That's just completely mind blowing to many people when you start walking them through that."

Institutional Investor, UK

"Unfortunately our knowledge on this is pretty limited, but we understand of course that biofuels are utilising grain crops and in order to develop alternatives to the traditional kerosene and that the synthetic is primarily derived from green hydrogen."

Institutional Investor, Australia

The SAF market is full of start-ups and strategic investors who are not necessarily in it for the financial reward

“For all the SAF startups that I’ve seen, I think probably 95% of them only have strategic investors versus financial investors. And I think that is indicative of at least the financial community just viewing this is a technology that is five or ten years away from achieving scale. It's possible that they're investing not for financial motivations, but trying to get access to new technology for their existing businesses.”

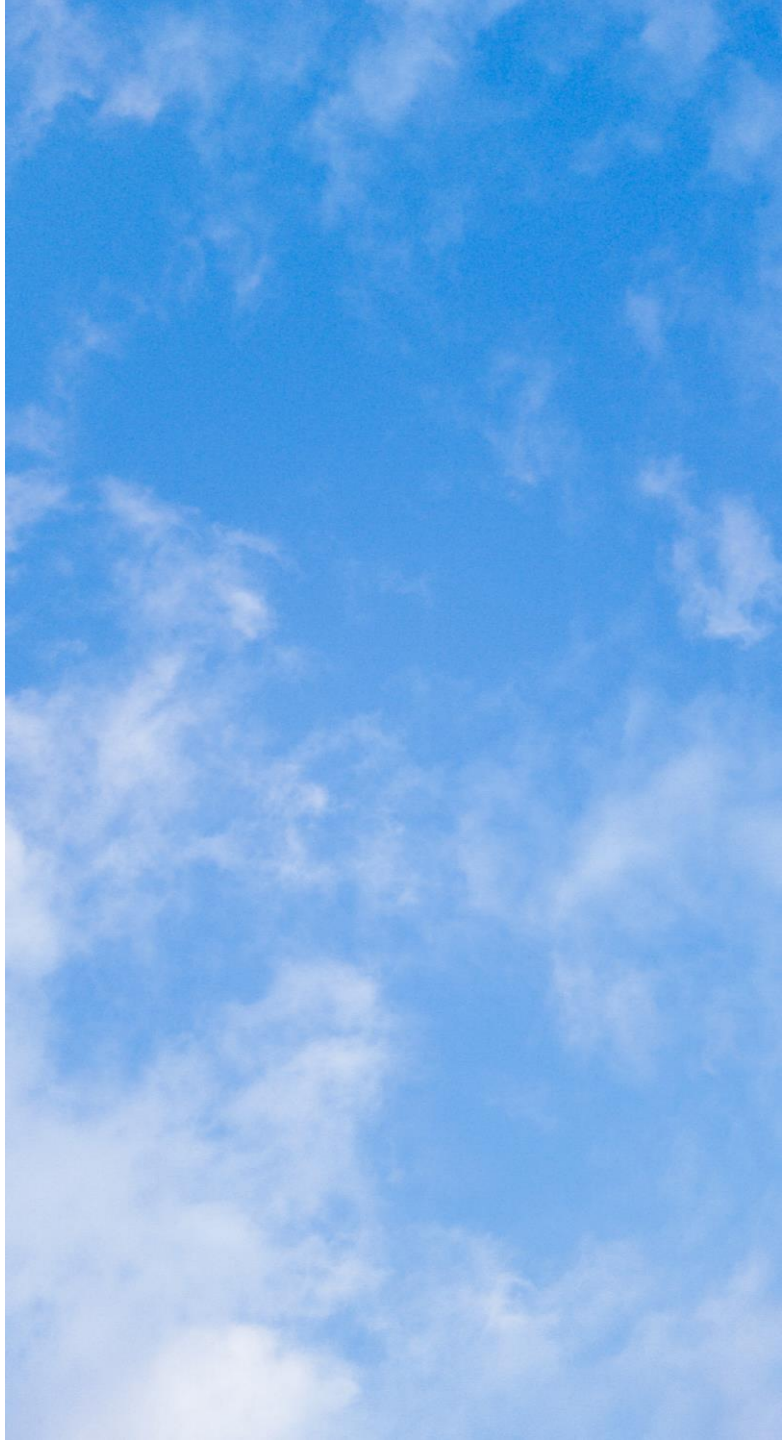
Venture Capitalist, US

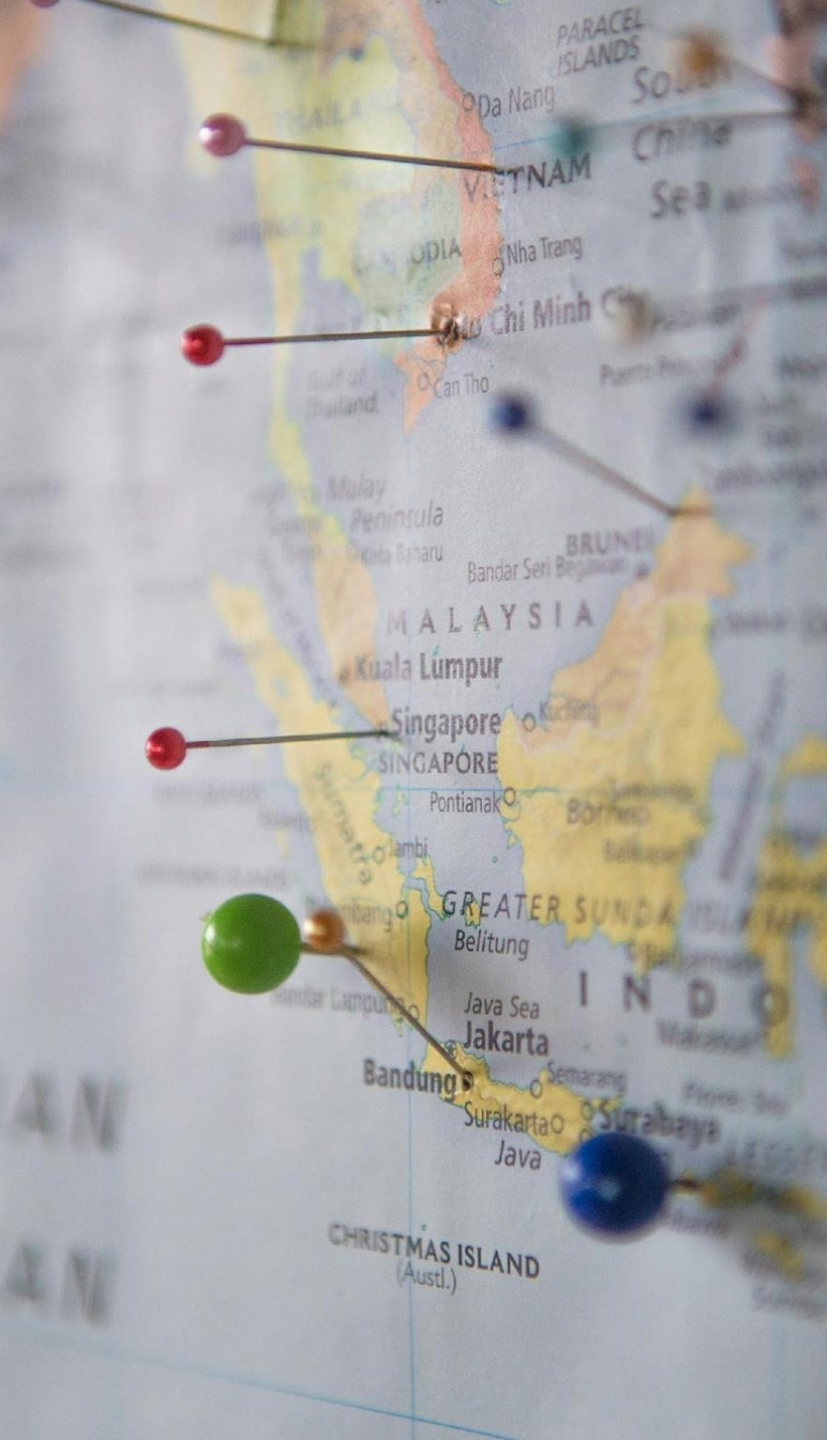
“There are more startups in this space than most people appreciate, beyond some of the well known players like Sunfire, Twelve and Air Company. There's a ton of early stage companies, I think over 50 that we're tracking. So a lot of exciting innovation and I think the key thing is just hopefully those companies have opportunities to do lab demos and then very small commercial highlights and in partnership with governments to try to derisk the technology development. But yeah, I think generally a lot of exciting startup innovation.”

Venture Capitalist, US

“It was a really hot space last year because of all the proclamations and the policy movements in Europe. It gave investors some confidence that this was going to be a thing. All the airlines are looking for SAF and they're throwing money at it and they're signing offtake agreements, but the offtake agreements have no teeth. They're meaningless. It's only if certain things are met that they will actually purchase the offtake. So we don't consider them viable, meaningful offtakes.”

Venture Capitalist, US





Regional differences in resources, incentives, and legislation shape SAF production and its environmental impact

"Any SAF project has to be able to recognise that geography is destiny. Meaning where you decide to build the project brings a whole set of expectations, not the least of which include legal requirements around the SAF and how it's made and distributed, and then what credits it qualifies for depending on the geography that you're in. I can't think of another space in sustainability that's moved as quickly as SAF has, and has as much complexity to it in terms of the differentiated approaches to the way that it is being received by governments and industry."

Institutional Investor, US

"What we have in terms of wealth of resources, in this part of the world. (…) a lot of questions being asked on whether palm oil can be used for SAFs as well. As you know, Malaysia and Indonesia makes up the top producers of palm oil globally. There are keen eyes to look at this area from an investment lens."

Venture Capitalist, Southeast Asia

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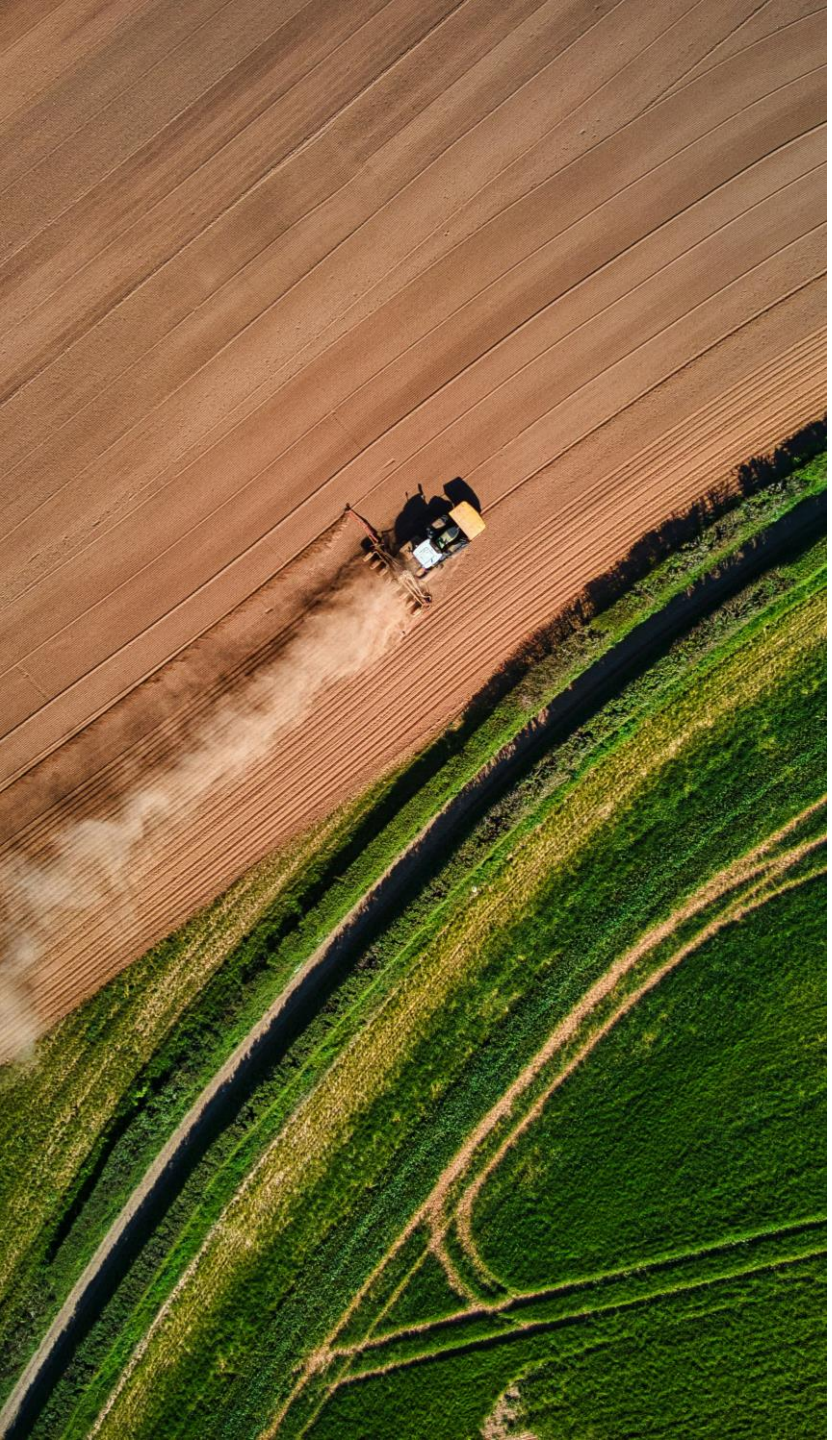
Investors globally see the catalysing impact that EU regulation has on the SAF market

“I think from an investment perspective, obviously we are looking at financial return as well, right? I think to the extent that we see how regulations are shaping in Europe for decarbonisation and potential carbon tax and whatnot, the move for moving towards higher adoption of SAF is a lot more visible compared to regulations here in Indonesia or Southeast Asia. So, from an investment perspective, in some ways we have a bit more time to see until the regulations makes it a lot more mandatory for the airlines to actually shift to SAF.”

Venture Capitalist, Southeast Asia

“I pay close attention to the fuel sector globally. And what I've seen is Western Europe is way ahead of the United States in e-fuels. There must be a dozen or maybe two dozen small startup companies in Western Europe that are offering an e-fuels technology. In fact, I believe there's a non-governmental organisation, meaning a trade association for e-fuels, there may be more than one now - and I stand here in the US, and I look with envy on this rapid deployment of e-fuels in Europe and say, why do we have virtually no e-fuels in the United States, when intuitively it would seem to be a lower cost way to make fuels.”

Institutional investor, US



Producing crops for biofuels poses moral questions of food security and land use. They are an interim rather than long term solution

“Are biofuels the best use of crops? Increasingly we are thinking about food security and supply chains. There is quite a potential moral hazard or social licence risk if we've got clients who are investing in biofuels and corn is being used to produce jet fuel when people are going hungry. So I think we'd have to be careful about that element of it. And not just be careful, we need to understand it and make sure that the risk is being priced. But I think that is something to consider from a moral hazard perspective.”

Institutional Investor Advisor, Australia

“So a couple things on the crop-based approaches. We view that no different than ethanol for gasoline and that still has a very high carbon footprint. It still takes energy, fertilizer to grow crops and turn them into some sort of fuel. It's a good interim solution and there's already companies that are doing that out there.”

Venture Capitalist, US

“If you ask me, should you be doing e-fuels or should you be doing biofuels? You should be doing biofuels to the point where you're not having an adverse impact on the planet, but that's never going to get you enough biofuels to completely decarbonise aviation.”

Venture Capitalist, Europe

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There's actually a lot better things to do with that fuel or that feedstock material than go into fuel […] If you've got a higher energy utilisation pathway, you should take it so, as opposed to making it into fuel for burning. It would make more sense to put it into synthetic plastics or bio plastics or into synthetic lubricants. There are more useful things to do with that biological material and more high value things to do with that biological material than make fuel out of it in the longer term. If you assume everything is going to get to net zero and if you've got a limited amount of biomass, you probably shouldn't be using most of it to make fuels. There are other areas that you're going to need to displace more in the chemicals industry. So there's a limit to how much the biological route can do today without having unintended consequences.

Venture Capitalist, Europe

Even waste-based pathways run into issues of scale

“The challenge with those other elements, the waste to value ones is they haven't proven A) that they can scale in that way, at least the ones we've seen and B) that there's enough feedstock to make one or multiple plants financially viable.”

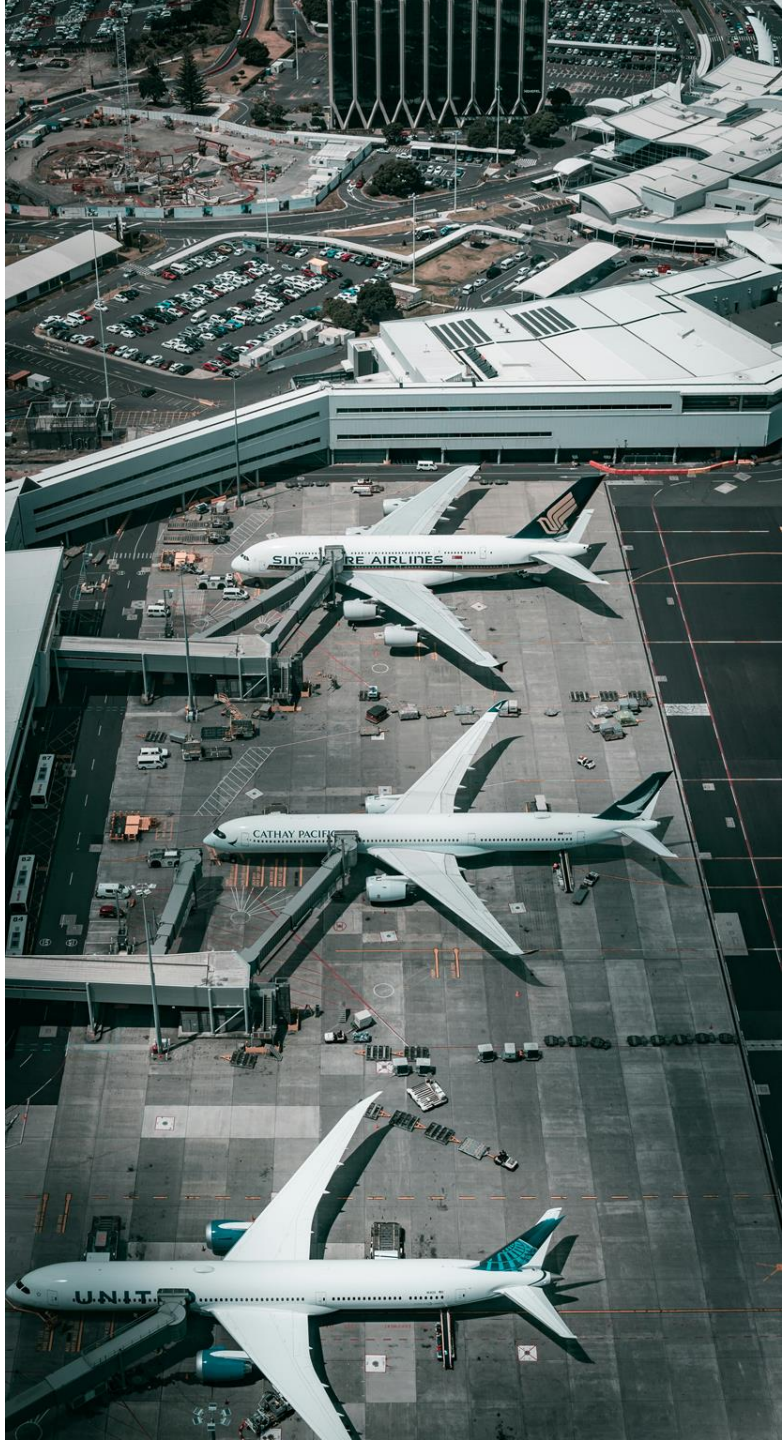
Venture Capitalist, US

“I think it's apparent to most people that at current pricing, you can probably still produce HEFA fuel and be profitable under current incentives, but the issue is that as with any feedstock, as you continue to consume that feedstock, the price of the feedstock also starts to climb. And at some point you likely face a scenario where the existing incentive no longer makes sense because we've climbed to a higher price point.”

Public/ private consortium, US

“All the biofuels are going to run into problems around the source materials that they require. I mean they have the same sort of problems that most waste to value solutions run into, which is that if it's really successful, you're not going to get enough waste to get where you need to get to.”

Venture Capitalist, US



PtL seen as best for decarbonisation, but the cost of hydrogen and availability of green energy are key limitations

"Power-to-Liquid fuels would be the best possible solution from a decarbonisation perspective - from what I understand you'd have the highest reduction in total emissions.(…) But I think the challenges with Power-to-Liquid fuels are that the economics are dependent on, of course the baseline price of jet fuel, but additionally, most of these startups are betting on green hydrogen costing a dollar per kilogramme or less, which is the cost parity target that all the green hydrogen companies are going after. But that's far from clear when that price point will actually be reached, I think it's probably 2030 or beyond. So even if you have a lot of exciting innovation on the catalyst side of things (…) you still fundamentally need very, very, very cheap hydrogen."

Venture Capitalist, US

"The idea of significant availability of renewable power, that all sounds fine, but typically when people think about that, they're thinking about that power being linked to the grid, for good reasons. It raises all of the issues that we have not just here in the US, but around the world about grid viability, availability (…) there's no easy solutions with respect to PtL other than the final conversion process - when I have this syngas, we know that the conversion process has been demonstrated. So that's a good aspect, but everything prior to that is extremely difficult. (…) The challenges are immense and so that doesn't give me a lot of hope that PtL fuels actually help resolve a lot of the issues that we've seen over the last decade."

Public / private consortium, US

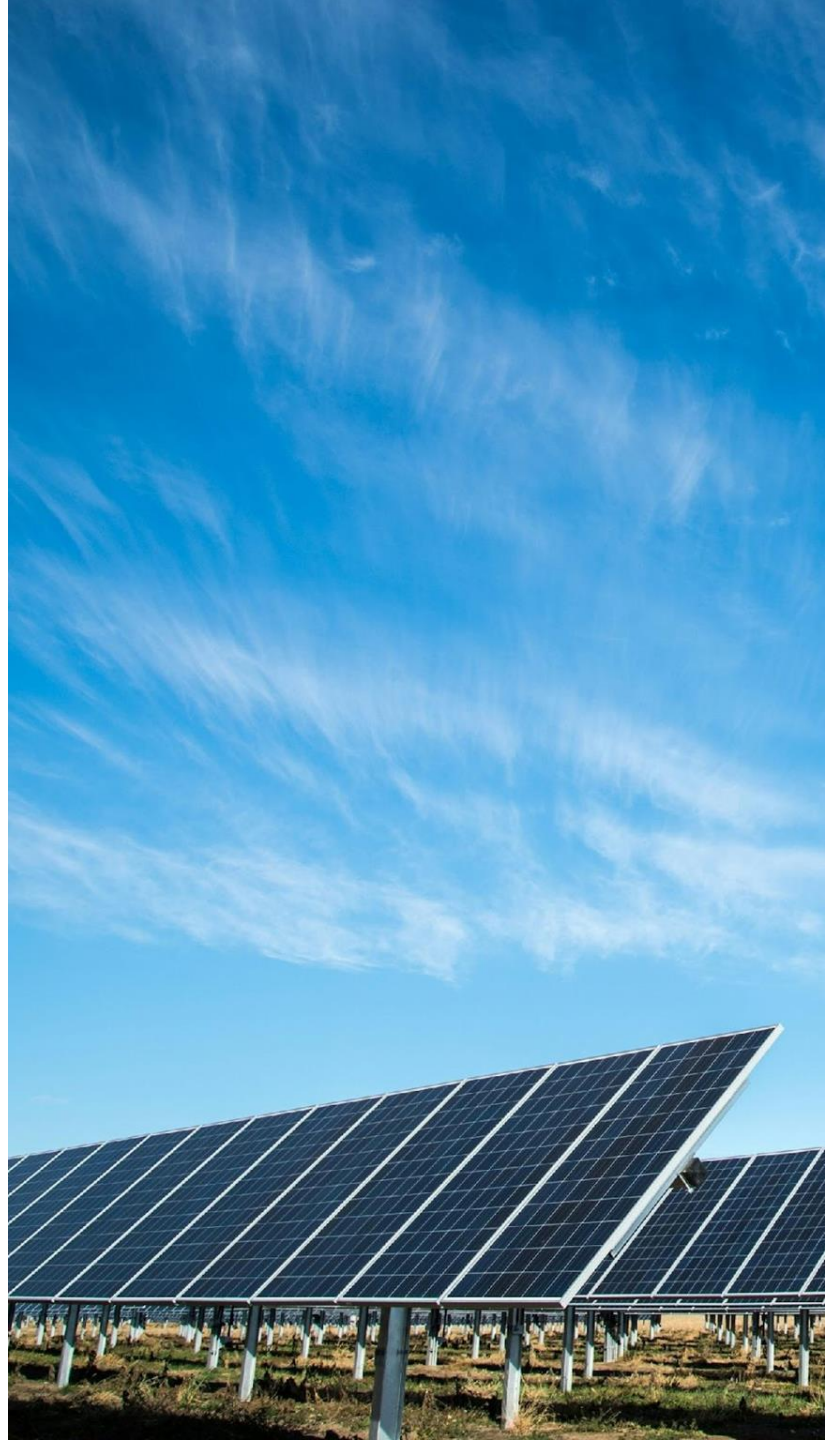
Taking a holistic view on net zero targets, the green energy going into SAF will be needed for other uses

“We need huge volumes of power in order to be able to produce e-fuels. And I just don't think the industry thinks about that. There's always talk in Ireland ‘we have this huge resource in offshore wind potentially we can use it to make hydrogen.’ […] But we also need it for SAF and we also need it for everybody's electric car. This is going off on a tangent from where the investors are, I don't think that they think about that, but those of us that are climate knowledgeable-ish or as as much as we can be … that is going to be a problem with e-fuels.”

Law, Europe

“I have a hypothetical to address to you. The green power that's in the US and the green power that's in the UK and Europe is already dedicated for particular uses, essentially the grids, so we can't repurpose that. […] I'm not trying to be difficult, but it takes a while to develop new installations of green power from wind and solar. And you have to have the land or the sea area to be able to do that. You can't take existing power sources that are being used to guarantee that traditional electricity going to homes and businesses and industry across countries and then say, well, we're gonna deploy a significant part of that to make SAF because you can't satisfy all the customer demand that there is.”

Institutional Investor, US



Some interviewees questioned the overall viability of SAF as a solution to decarbonising aviation

SAF is an incremental change, not an overall solution to decarbonise aviation

"The problem with aviation is that we don't have a technological solution, right? What we're doing is incremental changes and even SAF is an incremental change to decarbonisation. So yeah, cool. We can have fuels that are additionally better, but truth is we're still emitting a lot of emissions through them until we get to hydrogen, green hydrogen or blue hydrogen, it's still kind of not great. Batteries, once again, because of the drag and the weight of all that, we're still decades away."

Insurance, Canada

Energetically, kerosene and carbon capture makes more sense

"Energetically, you should continue to burn kerosene and you should do direct air capture. From an energy balance perspective you'll approximately be two to three times more efficient doing that. From a carbon perspective, if you have the same MW/ hour of power and use it for direct air capture versus creating sustainable aviation fuels, electric fuels, you'll save twice as much CO2. […] Physics says that that is a more efficient route. That is what should happen now."

Venture Capitalist, Europe

Everyone is now excited about climate. Different people have different approaches to what they think, even those who are super rigorous on the climate side of things […] if you look at SAF and e-fuels in isolation, you always come to the conclusion that you should do it. But if you look at it in isolation, you ignore the rest of the picture. And if you look at it in isolation, you have to believe that there's going to be an abundance of electricity and not just an abundance, but a massive supply in Europe.

That's a really difficult thing to believe because we're already going to need to double electricity production to decarbonise heat - industrial heat and residential heat - and transportation, probably a tripling of power. […] You want to basically use all of the existing power generation to power aircraft - that is a lot of power. If you want to put solar panels across the Sahara desert or central Australia - maybe. But in Europe, that's already a challenge in decarbonising the other sectors and the other sectors are way more efficient to decarbonise.

Venture Capitalist, Europe

03

Investing in SAF

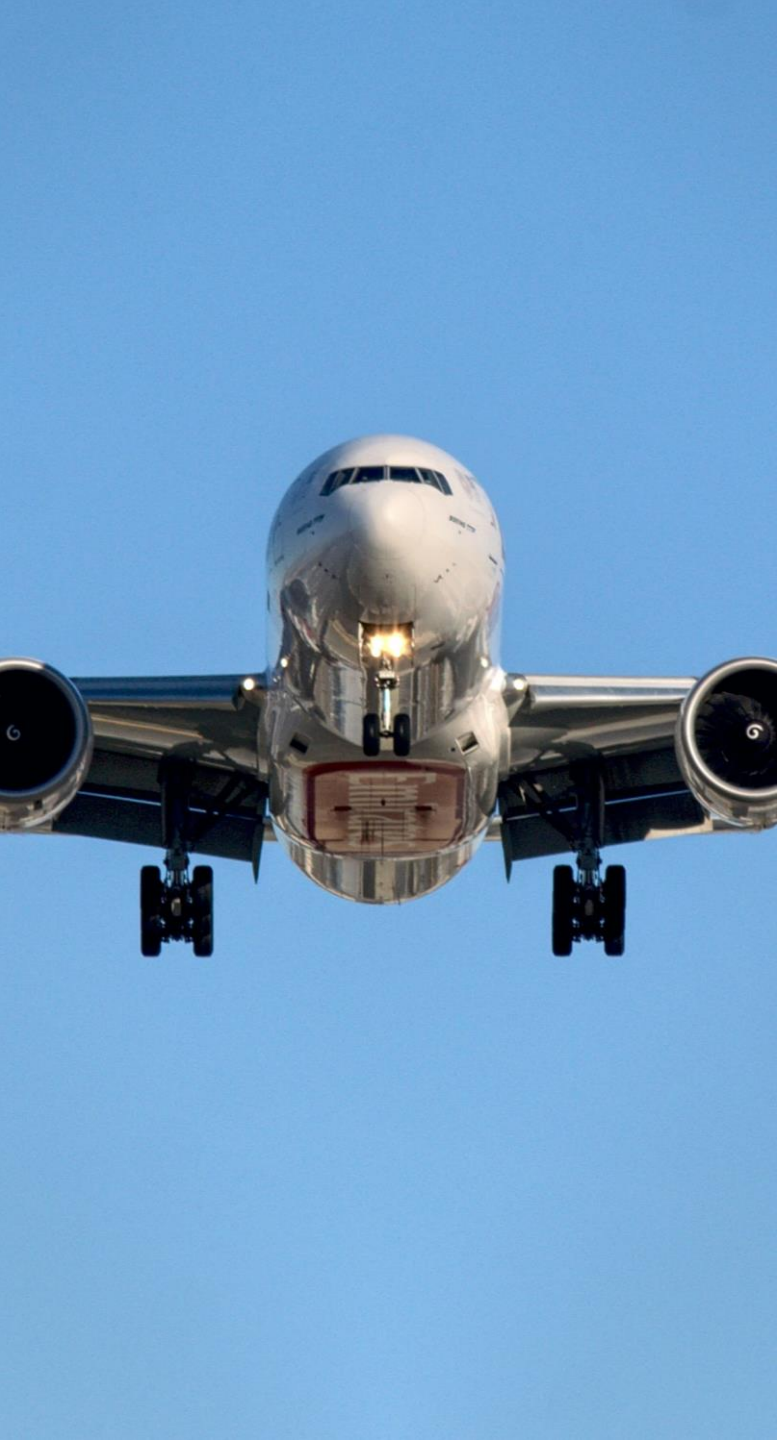
Summary – barriers and opportunities to investing in SAF

The major barrier for all investors is uncertainty about a return on investment. The reasons for this uncertainty are:

1. SAF is expensive to produce, which means SAF is still costs more than kerosene.
2. The sector has too many small producers with different pathways – it is difficult to know which approach or company is going to be successful
3. Investors want to see evidence of scale. They want to see SAF production scaled up, or at least see compelling plans for scaling, which not many have.
4. Absence of ‘big players’ - institutional investors, major oil and gas companies, and insurance companies are not yet significantly investing in SAF.
5. Many investors see SAF as one of many approaches to decarbonising aviation, and are spreading their investments across other solutions.
6. Offtake agreements get mixed reception – some believe they ‘don’t have any teeth’ and others questioned the creditworthiness (and thus dependability) of airlines.

“I don't know if it’s appealing [SAF] because I think the investors are only really worried about two things. One, how risky is it and then how much money if we invest in it, are we gonna make? And that's their job. Their job isn't to fix the climate. Their job is to invest limited partner money and investor money in things that are going to actually make money and that's the ultimate rub. Sustainability has to come in contact with capital every day in a whole bunch of different forms. And if you don't have alignment between the developer and the investor. There's no way that these projects are going to be built.”

Institutional Investor, US



SAF has to be cheaper than kerosene for airlines to afford it

“We were investors in […], which is a sustainable aviation fuel company, one of the leaders in e-fuels. So I know quite a bit about that. It's a heavy lift. It’s extremely difficult for that to ever make sense economically.”

Venture Capitalist, US

“We are to a degree mindful of the current costs of producing sustainable aviation fuels. There is a difference, a quite substantial difference, between bio based and synthetic, so that would be something that we would have to understand better to see what the investment opportunity would actually be.”

Institutional investor, US

“One is you need an offtake from an airline and it's very difficult. It takes a long time to develop trust with an airline and get them to provide an offtake agreement (and we can talk about how offtake agreements work and what the terms are). Then you've got the issue, which is central to the entire industry, which is that the airlines cannot afford to pay a price for the SAF that a developer produces without some other subsidy or incentive. In the US, we have the renewable fuel standard, the low carbon fuel standard, both of which are economic incentives that can be added to the revenue generation for the SAF developer, and then you have the issue of : what is the airline willing to pay for the SAF and how do you make up the difference between what the SAF costs to produce plus a profit and what the airlines can afford?”

Institutional investor, US

Cost and scalability are key investment considerations

“The main challenges that companies tell us is around fuel affordability, fuel availability - mainly the feedstock - and then also accessibility. So the affordability, the fact that SAF prices are much higher than the fossil fuel, that's one of the barriers I think need to be overcome. That being said, the projection shows that it's meant to come down towards 2030 and further after 2030, though that is somewhat dependent on what sort of regulatory measures are available. Then the availability - I think limited feedstocks and then also high cost of some of the technology like direct air capture or the carbon capture technology. Accessibility as well as availability. Just comparing the aviation sector and the shipping sector that I also cover. I think aviation sector is slightly ahead of the shipping sector for a couple of reasons. So SAF is a drop in fuel, whereas for shipping it's not. Another key difference between these two sectors is that within the aviation industry, there's a clear sort of definition or guidance on what's considered sustainable aviation fuel and that doesn't really exist yet for the shipping sector.”

Institutional Investor, UK

“Every airline is going to sign up if it works and is cheaper. It's got to be cheaper than the existing solutions. It's got to be 1 cent per gallon cheaper, or .1% cheaper per unit. You know, just to just to give people whose Profit and Loss is affected a reason to switch. It’s go to be a drop-in solution. Can't require a lot of reengineering about anything or any reengineering, and it's got to be commercially scalable quickly.”

Venture Capitalist, US

“I don't think hydrogen or electrification is going to happen in the short term […] mostly just because the cost is too high and the benefits are too far away. So what would have to change is the solution that is on offer, and SAF is maybe that option, would have to be cheaper than the incumbent – oil and gas today. It would have to be cheaper, would have to be a better solution on the business side, regardless of what it is on the climate side.”

Venture Capitalist, US

Scaling is a major barrier across the climate venture / green technology space, not just limited to SAF

“A lot of companies that we see in the climate space are on a hope and a dream. They're super cool technology and they’re super high impact, but they don't really have a business model or revenue plan or a sales plan.”

Venture Capitalist, US

“Something generically that we need more of in the climate tech venture startup space is pools of project financing that specifically allow climate tech companies to scale. I would say this is ubiquitous, not just SAF. But building someone's first plant because you know, a lot of these companies are scaling. They're going from making a gallon to, call it 10,000 gallons or 10,000 barrels or whatever. And being able to finance scale and finding partners to do that is super important. Not too many venture funds know and understand it. Well, I think they understand it, but they don't necessarily… It's not a sweet space for them.”

Venture Capitalist, US

“In an ideal world we would be throughout the entire journey and we would have a financing product, whether it's equity or debt, that fulfils the need for that startup. It would transition over time and somebody would have that role because I think it's a real unmet need to have a financing partner that can offer the early stage equity which is common, but then transition over time to more project based. With project financing you still have to have an equity piece. So they kind of have to work together eventually. But it starts 100% equity and then it would end up in favour of debt and equity. And so that that would be ideal if someone did it.”

Venture Capitalist, US

[at tech climate summit by Prelude] there must have been 75 climate tech investors there… I would say about half those investors made investments in the SAF space in one way or another and most of them are probably regretting it. It's like, oops, this was harder than we thought. This is going to be hard to scale, so there's a lot of talk about, OK, who funds the first plants, right. That's the big risk. It's relatively easy [for a small plant] of 10s of millions of dollars to build a small pilot. But that doesn't really tell you anything about the economics, how you scale, and the scale up risk. And these companies are trying to build refineries. They're trying to duplicate the existing [infrastructure] - it's not all that different from an existing crude oil refinery. And it's a lot of money. We're talking hundreds of millions of dollars. We had some late-stage financers on stage yesterday, these are the big financers with multi billion dollar funds that want to invest in infrastructure, climate change infrastructure and they all said 'no, we're not seeing it. We're not investing in companies. We're not placing our bets until these companies show a viable path to profitability'. They didn't talk about SAF specifically, but that's definitely one of the ones where that story is really hard to tell. The path to profitability. I just don't see it.

Venture Capitalist, US

Scaling SAF is very complex and requires the SAF developers, investors, lawyers, engineers, contractors and insurers to work closely together

"I think this is a vitally important part of the overall SAF story that doesn't get enough attention. If you think about how a SAF project is actually built and constructed, the SAF developer will fairly early on have to select a contractor, an engineering procurement and construction firm - EPC contractor - to build the project. There are two phases for the project development. There's the engineering design called Feed - Front End Engineering Design, where the engineering firm, in cooperation with the construction firm, get together and plan out the engineering process for designing a construction approach for the specific SAF technology. Then the contractor builds the project to meet the specifications of the engineering folks. The Front End Engineering Design can cost 50 to over 100 million dollars. That's before you ever get to construction of the project. The projects are running 300 to over 500 million dollars.

Now let me come back to the technology risk. What I found early on in talking to contractors was that a contractor, when it builds something, it could be your house or it could be a giant project, they make a commitment as part of the contract that the contractor signs with the developer owner to build it on time and on budget. And included within that, they need to build it according to the specifications that the engineer provides. The complexity of building a first of a kind or one-of-a-kind large scale SAF project, it's not like a paint by number. There's a lot of ingenuity that the contractor has to bring and they can't do it perfectly. It's just not humanly possible. So that leaves the contractor with a completion guarantee, saying we've finished it. It's done. You can see it. You can turn it on. And what happens if you turn it on and it doesn't operate at full capacity? That's happened in a few projects […]. What I found was that when I asked contractors […] what would it cost for you to provide a guarantee of performance, Mr Contractor? They said it will cost $100 or $200 million more in total project construction cost charged by the contractor to the developer in order to guarantee the completion and the performance of the technology at scale. I said that's too expensive. That takes the project to a total cost of capital where the revenue generated by the combination of the offtake airline revenue and the incentives are not going to be high enough. The revenue's not going to be high enough to cover the cost of repaying the debt and then producing an equity return for the developer. We need a less expensive derisking mechanism for this scale up risk. And that's when I started talking to insurance companies."

Institutional investor, US

If investors aren’t comfortable with scale up risk, they won’t invest, even if they understand the technology

“…they had a panel of investors and most of the private equity and venture capital people who were on the panel were moderately supportive to unsupportive. Their reason was, and this is not news because it goes on in all types of sustainable technologies, not just SAF: we, the investors who have to put our money on the line and take the risk, ***we don't like the scale up risk that SAF represents****. So you can develop a pilot project of SAF at a small scale, but when you scale it up to something that's going to cost 300 million to 500 million or more, that’s a lot of money. Private equity and venture capital are two types of investors.”*

“We can talk about the strategic players like oil companies, who are finally getting involved with biofuels and SAF, but the issue really is if these different types of investors (private equity, venture capital, strategics like oil companies, sustainable funds like Breakthrough Ventures, which is the Gate's fund right, and Bezos has a fund, Sir Richard Branson has a fund) - there are all these different sources of capital, but the question is: are those sources of capital comfortable with the scale up risk? Given the fact that the history of SAF shows that the initial scale ups of some of the projects, including Fulcrum and Red Rock, both of which had some issues with respect to turning the plant on and having it operate at full nameplate capacity first time - I'm not picking on them because they've now sorted themselves out - but the point is, if you're gonna put a serious amount of money into financing one of these projects and it doesn't work: What is your recourse? Where are you?”

Institutional investor, US

Insurance industry wants stable business – SAF requires more research and higher risk tolerance

“New infrastructure? New technology? It’s not easy, because there's no actuarial data behind it, so that's been a bit of a struggle for some of them, even when you've got your second factory of SAF, that second factory is still technically a new technology. So you're still not going to be able to insure it very easily. And I can understand the hesitation of a lot of investors without that insurance guarantee. There are more and more insurance products that are being developed to bridge that gap: technology insurances. But they demand a lot of research. That's where the brokers are doing a lot of the work to try and understand, to try and bring the insurers (who want as stable a business as possible) to the table and to tell them look, there might be a little bit more risk, but you're asking for a higher premium. You're still going to get a bunch of money off this, and this is all of the analysis we've done.”

Insurance, Canada

“It's a huge problem. […] After 20 years of carbon finance, carbon price, just in the last 12 months have we had insurance specialists crop up in the carbon space. […] you've got companies that are providing specific, tailored insurance products to incentivize buyers to invest in carbon projects. And the same needs to happen in SAF, absolutely. I'm just mentioning that to paint the picture: we've had carbon finance for 20 years, I don't mean debt finance, I mean actual upfront investment by buyers and it's taken 20 years for insurance products to become available.”

Law, Europe

The perspective of an institutional investor - SAF, like many green technologies, is waiting for big money to roll in

"You get waves of investment, right? You have your governments that come in first and say right we're going to put some money towards this because no one's going to put private money into it, they're not going to make a return - private money only comes in when they can make more money. Then you get your Angel investors who say, hey, I think this is quite cool, I'm going to just throw some money at this. Quite often it's philanthropists or some people who reckon that they've got enough money that if they burn 500 million on various little projects, it doesn't matter because one of their investments became Apple. Then you end up with your venture capitalists. Then your growth equity people. So your venture capitalists are going in after the Angel investors and saying, hey, that one was actually good, let's do it. A lot of those still fail. Your growth equity people have seen the venture capitalists succeed and pick up on those. Then there's a gap. Your growth equity people have got to a point where they know something works on a small scale, on a short time frame. They cannot prove scalability. They cannot prove that it will work forever. They cannot prove that this is the technology that will take us into the future. And then you have a really long wait, and not much money and a lot of very scared, nervous people.

***And then you've got the banks and the investors, they'll come in once it's scaled up**, when someone else has thrown enough money into it and they know they're not going to lose anything. That gap is probably where SAF sits, and so many other technologies at the moment too. SAF, hydrogen, frequency modulation for grids. All those kinds of technologies that should help us become more green, so many of them are sitting in that weird little pocket, where the growth equity people are saying, well, we made our money and we're happy, but someone has to come in and buy you or do something with you because that's not what we're doing. We're going back to the beginning of cycle again. **And the banks are looking at it going, I don't know. That looks scary.** So yes, it's a big problem. What we need in the industry across infrastructure is people who are willing to take that risk. We've looked at things and said, 'OK we know it works small scale. We now need to fund you to become big'. At the moment there are only people doing that on the debt side, with really punitive terms, [making it] really difficult to get anything done. It's very, very hard."*

Institutional Investor, UK

SAF needs the big players to start investing to progress - “The banks have to get uncomfortable here”

“The problem is its cost of capital and project risk. […] There haven't been many of these production facilities that have been established that are actually producing at scale. The problem is that this is risk capital, like with every new technology. Like with carbon finance, renewable energy 10 - 15 years ago, the risk capital banks don't touch it. So it's the venture capital people that come in […] but then you get to a certain stage where you find some pre-purchase agreements with buyers of SAF and then to actually go and build, to deliver and meet that contractual obligation - you need to get a few 100 million of finance to actually get building and delivering and blending. […] If they're going to focus on SAF, I would get them talking to the banks, because the banks are going to have to get a bit uncomfortable here, otherwise we're not going to get anywhere. The banks are going to have to accept a level of discomfort to provide project finance to SAF production. That is just the reality. The banks want to talk a good game about climate change and ESG. They're just going to have to accept a level of risk. Because this is risk capital […] The venture capitals do and they can do the seed funding in the Series A, etc. But then there comes an inflexion point. We actually have to go and start building and delivering. And at that point, you need debt. You need hundreds of billions to come in.”

Lawyer, Europe

Three separate US VCs spoke about the impact oil and gas companies can make if they decide to invest

“I mean oil and gas companies have a lot of money right now, right? They've been quite profitable the last year or so. We talk to all of them and they they're highly sceptical, right? They see the interest from the airlines, they see the policy from Europe for example. So they believe that OK, maybe one day we'll have to get there, but not yet. All I've seen them do so far - Exxon, Schlumberger, Oxy – is invest in carbon capture. That’s where they’re making their bets. They bought companies in the carbon capture and carbon sequestration space. Each of those companies in the past year or so made big purchases in that space. I think you’ll see more of that. They're placing big bets on carbon capture. They're placing much smaller bets on SAF so far, so far. It could change. I think they struggle to see the economics of SAF just like we do.”

Venture Capitalist, US

“Any time you need to build a huge plant for something, even if it's like 10 years down the road, a lot of investors shy away from that. You know, they kind of go oh: Where's the financing coming from? And I think from our perspective, if any of the other companies get far enough along, you're gonna get a Shell, BP coming in and somehow building plants to do that work - cause it's just once they see it, you know… They [Shell and BP] might not choose to do it right now because it's too early stage… But I think if someone sophisticated enough and I'm not saying they aren't, but if someone’s sophisticated enough to realize that, then they might also say, well, I don't want to work with Shell or BP, right?”

Venture Capitalist, US

“We work with the oil and gas majors, we invest in all sorts of climate tech with them because they have really deep pockets and they're the ones that are going to build stuff for people like us to buy and use because that's what they're good at. So when you think about bioplastics, same thing, right? You know who makes feedstocks for plastics? Exxon.”

Venture Capitalist, US

Barrier of not meeting your fiduciary duty - if institutional investors set targets, they have to hit them or risk breaching their fiduciary duty

"The decarbonisation story, at least at this stage, is that in order to own assets that are currently carbon intensive to try and decarbonise them, if you don't make it by the year of your target, as an institutional, big investor, we would then be in a position where to meet our targets, we would have to buy carbon credits. ***If you're buying carbon credits, what are you doing in terms of your fiduciary responsibility to your investors*** *to get them the best return possible? So you're obligated to buy carbon credits, but you can't buy carbon credits because that would be unethical. So what on earth do you do? It's a bit of a catch 22 and incredibly difficult, and I'm not sure anyone has figured that out yet."*

Institutional Investor, UK

Airlines are not creditworthy and don't have cash, so are limited in what they can achieve

"The creditworthiness of airlines is the major problem for a lot of insurers. Every single SAF company is signing contracts with airlines. Wonderful, but ***airlines are probably one of the least creditworthy companies in the world****. I mean, they're cash poor. They have very little credit and they carry massive amounts of debt. So anybody who has a contract with them is the last person getting paid if they go bankrupt, if they go down. Which means that an insurer looks at that as like a yeah, sure, you've got $10 million of or $100 million of contracts signed, but you're the last one to get paid if things go wrong."*

Insurance, Canada

"United could sign offtake agreements alone till the cows come home for millions and millions and millions of gallons and it would only scratch the surface of what their demand is. So in some ways these airlines don't mind doing that because they know they need it, they know they're going to buy it. So it's a little misleading, I think you have to be a little careful about that. I think the average investor doesn't totally understand it, but savvy SAF people that have looked at this understand that […] it's actually not hard to get. It's kind of like a letter of intent right now. Some are a little bit more solid than others […] but I'm always careful to look at the order of magnitude of what's promised and what that would mean for each party."

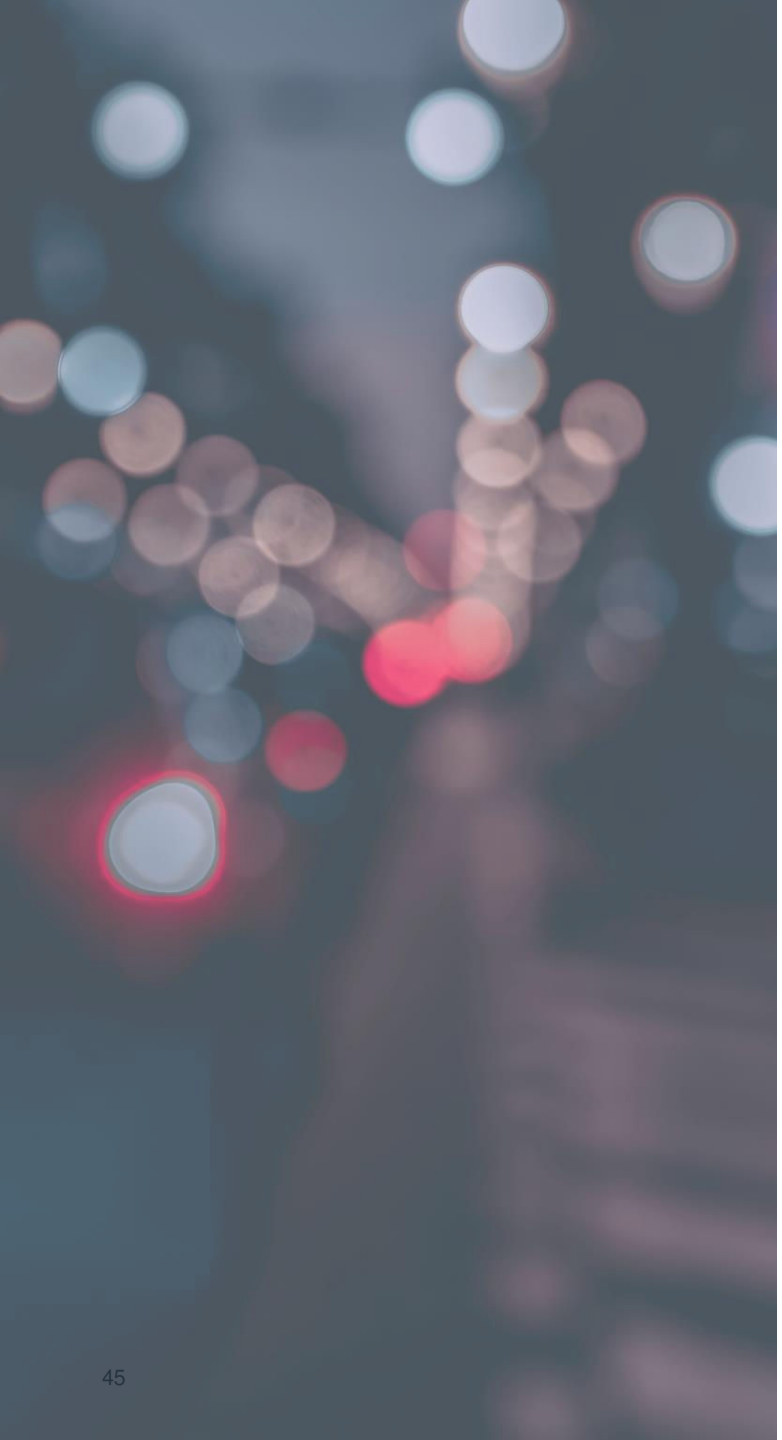
Venture Capitalist, US

"Only half of the world's aircraft fleet is actually owned by airlines [...] Most of them don't have the cash or the balance sheets to make any sort of dent in what's needed to decarbonise aviation […] no understanding of policy […] We need all of the other people in the industry, the financiers and the owners of the of the aircraft to step up because they're the ones with the investment […] They know how to structure deals, they know how to structure investments, they know how to procure debt, finance, equity, finance. […] The heart of the world's fleet is owned by these people […] They're owned by private equity firms. They're owned by pension funds and the OTP and the CDBQs of this world."

Lawyer, Europe

"All the airlines are looking for SAF and they're throwing money at it and they're signing off take agreements, but the offtake agreements have no teeth. It's only if certain things are met that they will actually purchase the offtake. So we don't consider them viable, meaningful offtakes."

Venture Capitalist, US



Some investors spoke about alternatives to SAF in the aviation space that they were more likely to invest in

"The potentially more attractive exposure that our clients might look at is actually investing in green hydrogen production. Ultimately that is one of the feedstocks for fully synthetic aviation fuels. So it's a way to benefit from those tailwinds without necessarily having direct exposure to the fuel industry. We know that green hydrogen demand is likely to be spiking over the near term, so that might be something that our clients might think OK. Or we might talk to our clients about look there's a whole range of applications for green hydrogen. Australia should really be in a good position to produce a lot of green hydrogen and it could be an attractive time to think about that, we are in fact having conversations along those lines right now about green hydrogen. The aviation piece is, quite interesting from that point of view."

Institutional Investor, Australia

"Light airplanes mean less fuels being used, right? So that's also good. Regardless of where the fuel is coming from, who's producing it, Whether it's pumped out of the ground or it's pulled out from CO2 in the air, less fuel consumption is better. Then there's other drive trains. Obviously there's hydrogen, there's electric planes, there's more efficient combustion engines [….] ***So we kind of view SAF as important, but just one piece of the solving the decarbonisation problem for the airline industry. So it's a big piece, no question, it's a really big piece and the airlines very much have a vested interest in solving for that.*** *But it's gotta be a more complete look at the technology ecosystem supporting airlines."*

Venture Capitalist, US

Some investors did highlight that SAF can be an attractive market and has potential to be profitable

“There's some wonderful examples of mega contracts that have been landed in the SAF market quite recently and obviously it's the well-known players. It's not the smaller players. But I think that has provided confidence to the market that this is something that can happen, even though a lot of these contracts aren't delivered yet.”

Insurance, Canada

“It's absolutely a very attractive market, huge growth area, potentially very profitable.”

Venture Capitalist, Europe

“Cemvita factory, based in Houston, TX, focusing now on producing SAF leveraging synthetic biology. This is a on a lifecycle basis. This is a carbon neutral solution. I think this is a very exciting breakthrough in terms of the technology and they're able to scale that solution on a massive scale. […] Cemvita’s factory actually has signed the largest sustainable aviation agreement with United Airlines. For an offtake of roughly up to a billion gallons of fuel over the course of the next 20 years.”

Venture Capitalist, US

04

Mandates and regulation

Summary - mandates

- Mandates and regulation are essential in creating markets. SAF needs the regulatory support to be able to compete with the price of kerosene. One investor praised the UK Government's proposed price mechanism – subsiding the difference between the SAF producer cost and what the airlines pay.
- ReFuel EU is influencing behaviour, with some SAF suppliers moving to the EU to accommodate the increasing demand. It is also attracting investment to EU SAF producers. The US Government has used the model of incentives. Generally, investors would like to see both approaches adopted.
- One lawyer highlighted that if governments stated what the penalty for non-compliance of phase 1 of CORSIA was, this would speed up aviation's path to decarbonisation (and likely adoption of SAF).

Regulation or governments have to cover the price differential between SAF and petroleum-based fuel

*“The UK Government, through the Jet Zero Council, has posited the idea of using money from the UK government to support a price mechanism which would address the difference between what the SAF developer needs to be able to charge to recover their costs and make a slight profit versus what the airlines can afford […] to me**, that's one of the most forward-thinking approaches**. The other approach […] would be using the low carbon fuel standard as an additional revenue source that would be eligible to be used by the developer. Another one would be carbon credits - we now have a global carbon credit markets. Some are voluntary, some involuntary and there are qualifications that have to be met to be eligible for those carbon credits. This is a complex patchwork of revenue generation to support any SAF project, and the economics of it become really important to figure out at the very beginning.”*

Institutional Investor, US

“*So here is my view in a nutshell […]These fuels are more expensive to create than petroleum-based jet fuel. In some cases that price differential can be covered with policy and in other cases it can’t. And it varies by every pathway, which is a combination of feedstock and conversion process that has different challenges with respect to capital expense and operating expense. But all of them have this this price differential challenge. […] Where we're at today is we've got this extreme number of producers who are interested in satisfying the demand of the market and extreme level of interest on the market side and an **inability to close on the price gap**. We in the US fundamentally have this problem that our policy is not of sufficient duration to satisfy the capital markets. And so we're at a bit of a stagnation point, right? We don't have a mandatory policy mechanism in place that forces the use like you have in Europe right now. And there's a lot of debate here in the US, from a political perspective, about the role of government and liberal approaches and conservative approaches. […] think some level policy is absolutely required. There's no question. You can't compete with 140 years of maturity from the petroleum industry. And the fact that the current price of oil is not well above the marginal cost of production. And absent some sort of a global carbon pricing scheme, I don't actually see that changing much.”*

Public/ private consortium, US

ReFuel EU is influencing behaviour of SAF producers, incentivising production in Europe over other locations

Are you aware of the European legislation that would mandate minimum production targets?

"Yeah, I am. And that's what's really interesting about the way this is developing because some of the strongest offtake is for European companies. IAG, which includes British Airways, recently announced a very large contract that they signed with Twelve. It's very interesting even though some of that production is happening in the States, the offtake interest is there [in Europe], it's influencing the way that Twelve is building out its production facilities to make it easier to tie into those. That's the point I made earlier about moving from corporate social responsibility, which some people wanted to be an early kind of announcer of them doing these sorts of things. And then other ones are kind of going, no, we've got a serious problem that we're going to have to be dealing with and they're getting much further out in front of it. ***Europe is really going to continue to drive that scaling solution****. And hopefully those realities both create more of a road map for what is going to have to happen in the US, but also some urgency because I can tell you where the production is going to go right now.* ***It's going to go where the demand is willing to make commitments****."*

Venture Capitalist, US

There might be some laboratories in Australia who are looking at SAFs at the moment. But we're very much aware that it's more offshore from Australia and so it would not be a surprise that fund managers would be looking at markets where there are going to be structural tailwinds and for us, formalised regulation is definitely something to say - there's a positive outlook because there's a regulation in place. Our clients are happy to invest internationally if there's an opportunity to benefit from those structural tailwinds. So definitely policy and incentives and things like that make up a picture.

Institutional Investor, Australia

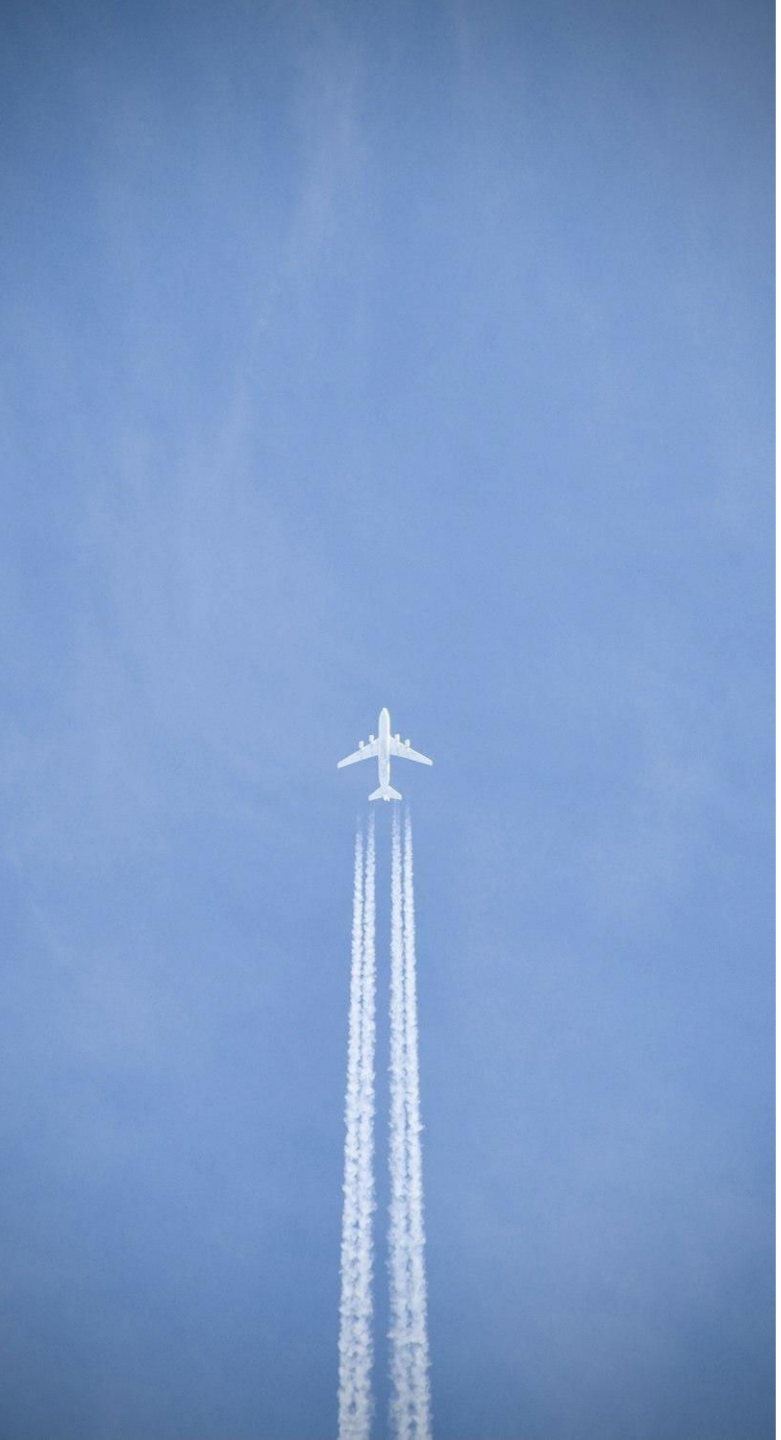
For investors, regulation is moving in the right direction in the EU and US, but more is needed

"The EU and US airlines are in a much better position [in hitting net zero target by 2050] than their counterparts in other markets. Obviously it's not just aviation, it's a challenge for other sectors as well. The sort of DM (developed markets) versus EM (emerging markets) divide, the specific reason for this is in the EU there are a lot of regulations surrounding SAF mandates. And then in the US they're taking a slightly different approach because rather than sticks, they're going more for a carrot approach where they're incentivising companies to produce more SAF, as well as adopt more SAF. I think that even though these approaches are slightly different, both of these regulatory frameworks are pushing for decarbonisation. I think there are definitely leaders, but even within the EU or US, which are the leading markets, I would say they're some laggers as well. Especially the low cost carriers will be in a worse position just because if you think about the cost of SAF and then how much the fuel costs represent within their overall expenses they are more likely to be squeezed."

Institutional Investor, UK

"There's been some limited funding from the Department of Energy loan programme office to try to reduce the financing costs for some of these large SAF projects that are a bit further along. ***So I think policy is moving in the right direction in the US*** *and of course the SAF tax credit from the IRA is also going to be helpful. I think unfortunately it's probably not large enough to really move the needle at the end of the day except in maybe some niche segments. You'd probably want to see either that tax credit increased in the US or actually have some sort of mandate put into place. Perhaps that's something that could happen at the state level or there's been some talk about requiring private jets, for example, to use SAF as trying to help jump start the market. But I think probably more policy support is required."*

Venture Capitalist, US



Positive impact of policy on SAF

“I think it's helpful and I would agree with those investors, the US does more carrot than stick on average. I think we're just less likely to do it through regulatory means versus incentives. I think the IRA has helped in our world, the investment world. The Inflation Reduction Act. It’s thrown a lot of money at SAF companies. To be honest I think that's my tax dollars not being well spent because I think there's been a lot of bad investments. A lot of companies that will never be economically viable have received a lot of funding. They're both from investors and from grants. It’s just a tough space.”

Venture Capitalist, US

“I mean, I don't really know too many industries where they're basically saying: we've set our own goal to reduce our carbon footprint by what is it like 50% or 30%? I can't remember, but it's a big number, right? By a certain date and we're investing in it. You generally don't see that kind of public pronouncement going after it. So that to me feels like everyone should be investing in this area because at some point there's going to be winners.”

Venture Capitalist, US

“It's possible that that can be done through incentives alone, but the incentives have to be strong. I think realistically the best case is actually both the incentive that goes along with the mandate. We've got reasonable incentives. They're not fully sufficient, especially with respect to duration, but if we had a mandate here of some type, I think that would certainly help and there's been some discussion around how that might be done in more of a US centric kind of approach versus the exact approach that the Europeans laid out.”

Public / private consortium, US

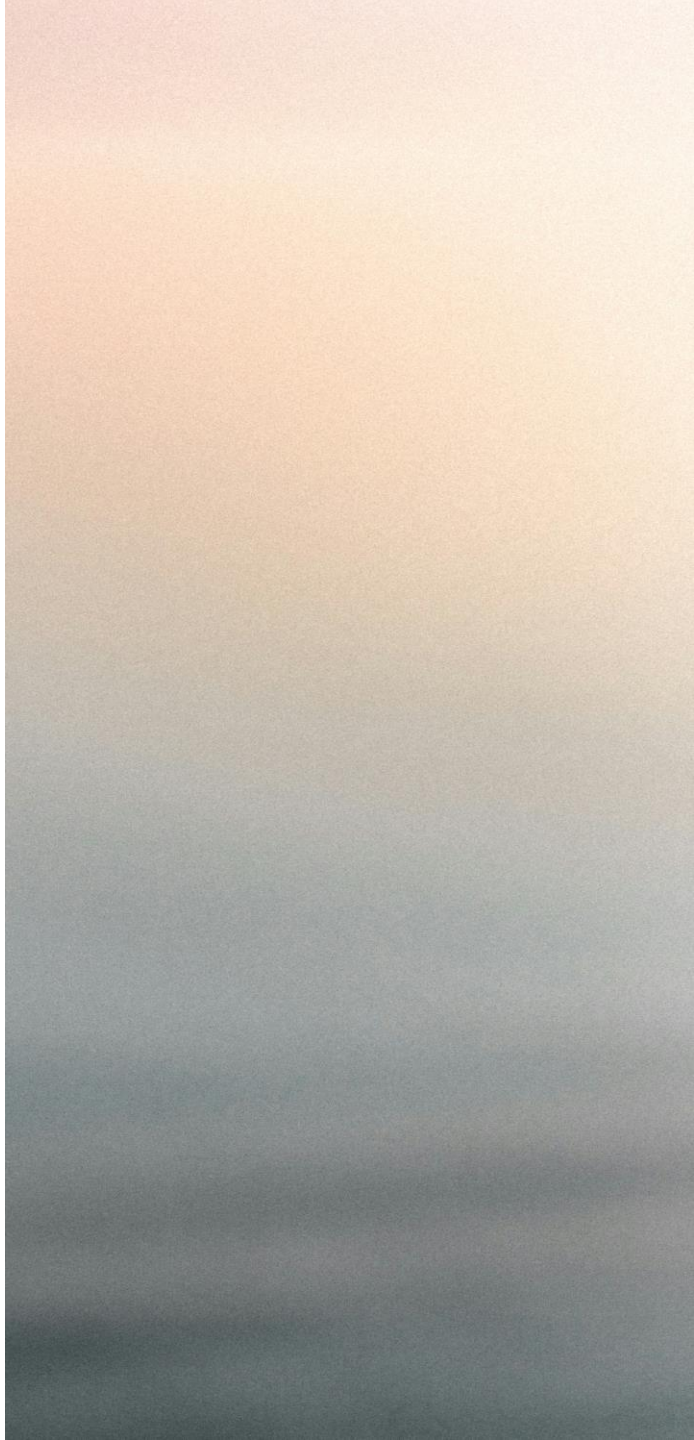
Mandates are a help in creating a requirement for SAF

“The mandates are a huge help in saying that there will definitely be a requirement for it. I think that there's confidence because [of] the way that SAF producers have said ‘we'll be able to hit the 2030 targets’, […] versus on the carbon finance side, where nobody knows where the credit is going to come from.”

Law, Europe

“What is currently missing from really pushing the aviation space into decarbonising and doing more on climate action generally? ***What's the one thing that is the trigger for more money going into climate finance? […] There needs to be a contracting state that has agreed to comply with phase one of CORSIA*** *[…] Somebody needs to, as a matter of priority, implement a regulation that clarifies what the penalty for non-compliance is. At the moment, we've got this global scheme that international aviation has to adhere to and it's going to be mandatory for everyone from 2027. So we're in a pilot, it's still in a voluntary / involuntary phase, but if your country has signed up to it, it's not voluntary for the airline, right? There's 122 countries that have signed up to it and there hasn't been a single country that has said yet what the penalty is for non-compliance and that's why the airlines are like ‘we don't really care yet because we don't know if we're going to be in trouble’ […] I know this discussion is going on at EU level and I don't know what the position is in the UK.”*

Law, Europe



05

Information sources

Summary of information sources useful to investors

- Investors like to speak to companies directly, or people who have invested / understand what it means to take a financial risk.
- Research reports can be useful to skim through when thinking of investing in a new field, but after that, investors look to speak to people with vested interest in the innovations / business.
- Conferences can be a useful source of information but are regarded by some as just talk / marketing – unless participants have invested themselves.
- Although information is not what is missing, there is a desire for more actionable data and a common language between insurers and investors.

Investors use a range of sources to build their knowledge of SAF

“There's so many different research providers that we use. Sometimes it's sell-side research, sometimes it's what is publicly available like Transport & Environment, Bloomberg. Other banks that have research, who have specific sector investment researchers or sector sustainability researchers or a combination of the two. And then either conferences or roundtables online where they bring in experts.”

Institutional Investor, Europe

“We looked at a lot of the different reports. It's really one of the main sources that we used, and we used a lot of different ones to try and give as much credibility as possible for our reporting. Looking at the limited availability of biomass, looking at biomass constraints. The German Government did a very nice piece on land use by the German Federal Environment Agency […] The CCC [Climate Change Committee] in the UK did a nice piece on what you can do with the MW hour of zero carbon electricity […] As many as possible is the answer and none that are sponsored by aviation.”

Venture Capitalist, Europe

“I think we do go to various sources. Obviously, the ones that are available publicly online, the research agencies particularly related to aviation would be one area. I would say a lot of the consultants also have been looking at it. So, if you look at the top management consulting firms, they would have some reports about this as well. […] BloombergNEF, they just released a report on sustainable aviation fuel globally. So, obviously [those] and many others globally are very much the ones that we would be reading and referencing.”

Venture Capitalist, Southeast Asia

“So when it comes to consultants, most of the times they are recommended or they already have a really good reputation.”

Venture Capitalist, Europe

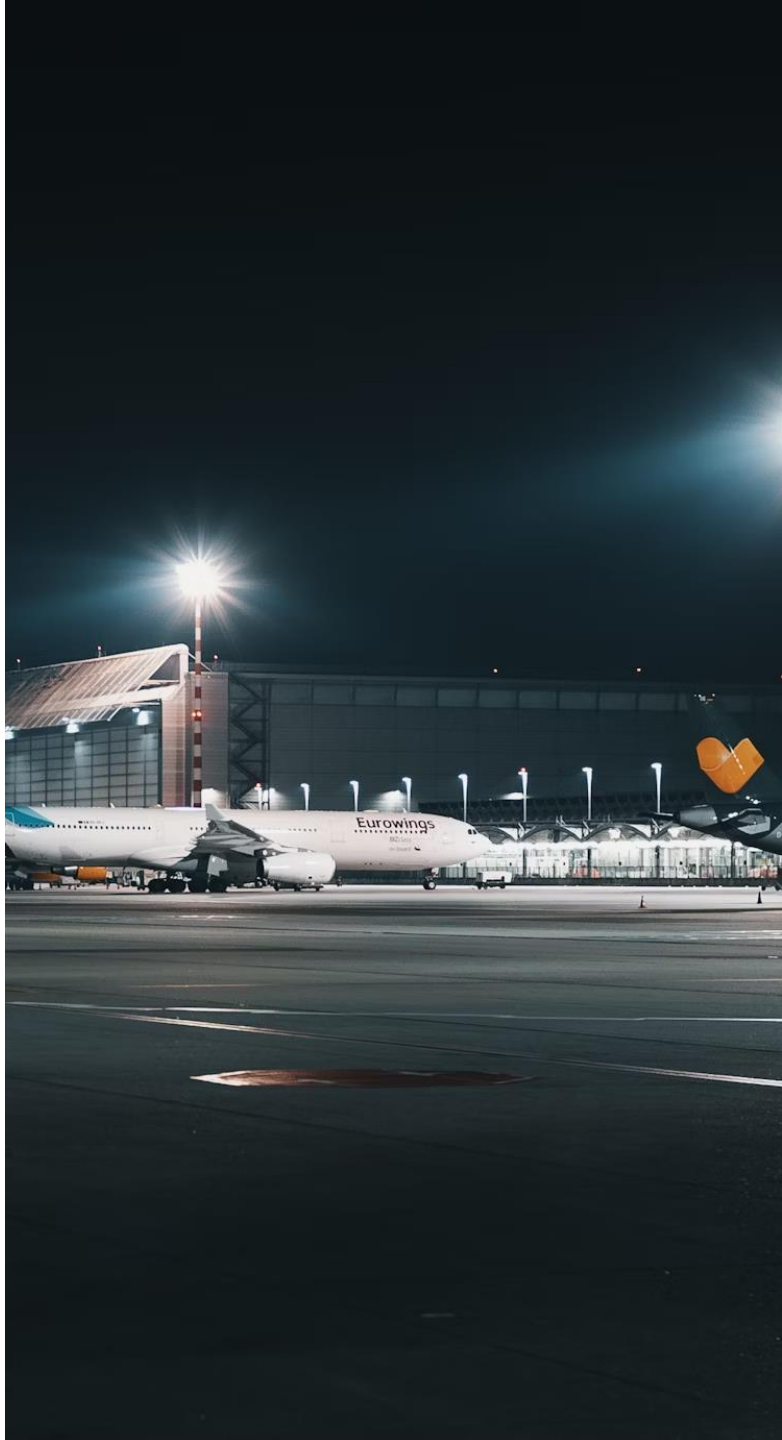
VCs look to speak directly with SAF producers or fellow investors

“Where I go to first? Well, I talk to the companies that are proposing it and I want to know what they're thinking, why they think they're going to be viable. And then I challenge - I tend to ask a lot of hard questions of the companies pitching us and try to understand what their assumptions are and unpacking their assumptions. I've seen a lot of pitches - we get around 800 deals a year, so we see a lot of thinking and these are smart people, they're smart companies and they're typically started by PhD engineers, chemists and so forth. They believe in what they're doing, they believe in their technology, they believe in the market, and so we learn a lot from them.”

Venture Capitalist, US

“Industry connections usually - we like to talk to people whose business is going to be affected by whatever innovation we're investing in. So, we tend to really over-index on potential customers, we call them, we talk to real people who really own profit and loss. Like I said, we avoid net zero officers and innovation officers […] We would call industry experts and airplane manufacturers and airlines. I think we would probably talk to people on the other side of the end, like people who have successfully sold into those, too.”

Venture Capitalist, US



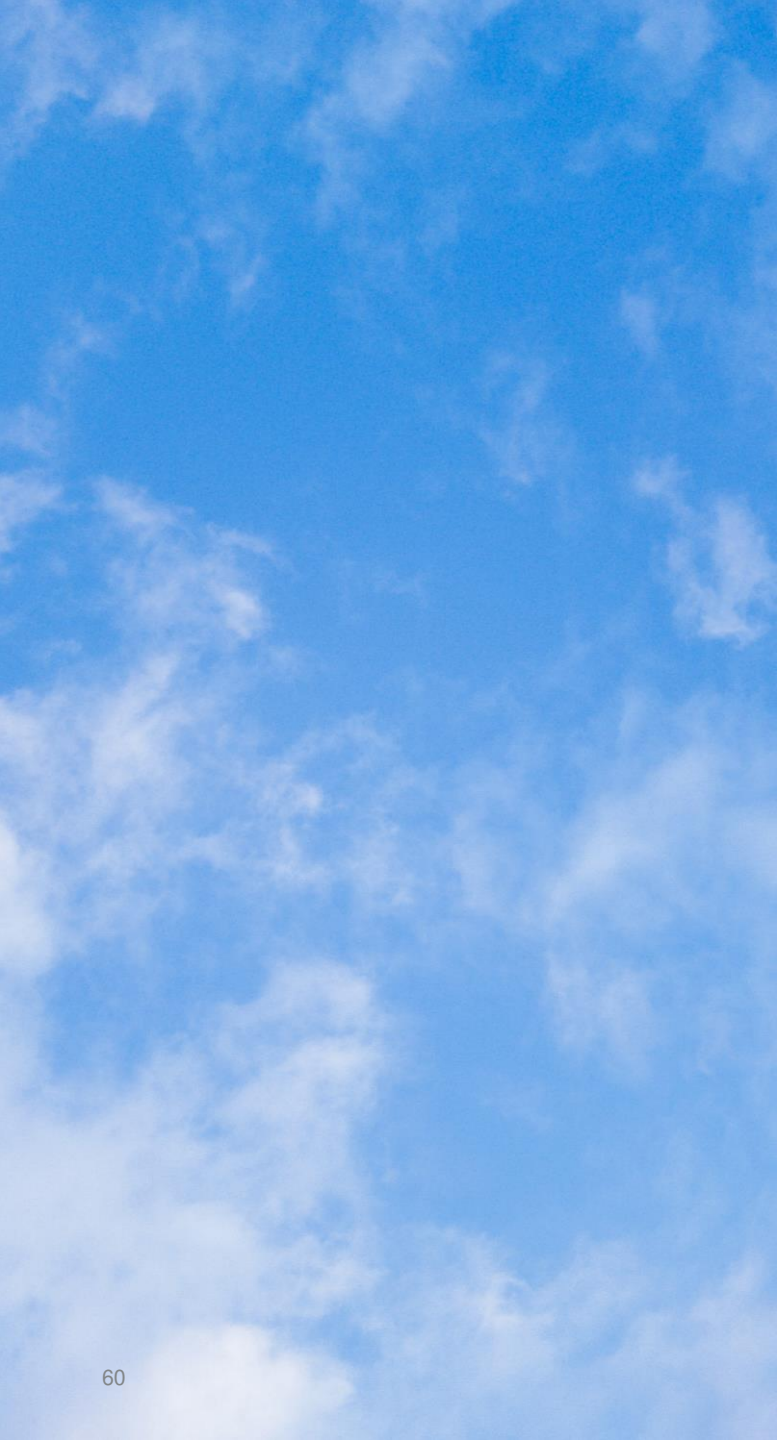
Some investors look for “real world” information more than high-level reports

“I don't put a lot of trust in research reports because usually a research report is written by somebody who's not investing and not buying. If I'm starting my journey into understanding the market, I might skim 10 research reports in that industry, because it is useful to ground yourself in this space. And then I usually love to look at profit and loss, and balance sheets for companies in this space because that tells a different story. Usually, the real one. That’s the other thing, oftentimes research reports or industry capstone reports or whatever really look at high level thoughts on the space instead of real world, on the ground things that are happening and being bought and sold those days. I really like the nitty gritty business side of the equation.”

Venture Capitalist, US

“What we often find is that there's research about how much investment is going to be required to transition, particularly this sector, which is what we'd definitely class as hard to abate sector. We would look at that high level research, but we want to know how, practically, our clients can put money to work. So, what is available in terms of investment products? What's the likely return? What are the fees involved? And if that information is available then we can put together we can use our own analysis to then make tailored recommendations to our clients.”

Institutional Investor, Australia



Conferences can be good if investors are there – but there are also elements of conference fatigue

“I just returned from my two day climate conference by Prelude. Prelude's a big investor in the space, we've got several co-investments with them. They've been doing climate tech investing for decades. There must have been 75 climate tech investors there, I know most of them because we're a small family. We all know each other.”

Venture Capitalist, US

“JetBlue runs a venture day. I haven’t been to one, but I know they do that. I don’t know if United does that but I think it’s pretty interesting”

Venture Capitalist, US

“When I’ve sat in conferences or other sources it's interesting and starts to get at it, but it doesn't really have the depth from an investor’s point of view that you feel like you're ready to go make that kind of investment. I would be trying to figure out with the airlines - because it may be we're trying to educate them as much as we are the investor side of it. Because they are going to have to really play a major role in how they're going to fit this into their supply chain. And I don't know which conferences that would be, but it feels like there's a time to be able to really generate a lot more commitment to the demand side. So that gives people confidence that they can keep pouring the money in on the supply side. I don't think there's a question any longer about will this work. This is largely an execution problem and putting the money in up front to go just build out that capacity much faster.”

Venture Capitalist, US

Information is not necessarily what is missing – actionable data, a common language between insurers, investors etc. might be

“The information is out there, and the investors can get the data, they can get the information. Often, it's not useful enough for them, that's the excuse ‘I've got the information, I got the data now, but it's not creditworthy […]’ But you make decisions based on partial information all the time. That's your business, right? You do not have perfect information, so stop using excuses for not investing in this. So, there is an educational piece, I think it's more on the hydrogen side than on the SAF side. But I'm not sure perfect information is what's going to help here. I think there's a need for common language. And some of the fundamentals of how investors work need to be understood, whether they're happy with investing pre-FID, post FID, with insurance, without insurance, self insurance, whatever it is, or guarantees provided by someone else, whether it be the state, whether it be a larger institutions. Those fundamentals of understanding the investor - and I say investor not investors because each one has a different risk appetite. Each one has a different approach, so I would suggest the ideal is to find 2-3 that really you can dig in and understand how they work.”

Insurance, Canada

Investors making deals in the aviation sector look for information that is not necessarily in the public domain, often proprietary data.

"On SAFs, the kind of depth that I've been talking about here, I don't see it anywhere outside of the research that is being done by the companies and investors making sure that they have enough depth on this. If you want to get to the depth in this research, you almost have to go there. I think there's a question about whether somebody could partner with some of those organisations to get at that information and be able to make it more available publicly. I know some of the stuff is very much proprietary because they want to be able to understand where they are from a cost position. But I think the knowledge that you're trying to make more broadly available at this point, it's known for anybody that's making the kind of bets that are getting made here. […] If you can find ways to get that information out more broadly, and again it's for what purpose? And for me it's ploughing the grounds for the public markets on these things."

Venture Capitalist, US

"There's limited credible, recent, highly detailed analytical work on this SAF space. The best work I've seen would be from Rhodium group. McKinsey had done a really lengthy report a few years ago in partnership with an NGO. I would imagine the Department of Energy is planning to do a report on this soon. They've been doing this series of lift-off reports that have been very helpful for our technologies. But I think generally it's hard to sense check the cost assumptions when looking at these startups across the four main technology classes. And then really trying to double click on 'are they saying they get to price parity with jet fuel because they are assuming free hydrogen or because they're assuming free electricity input costs or because it has an incredible new catalysts?' And sometimes it would be great if there's a publicly available model or just more rigorous report that allows you to sense check those assumptions more thoroughly."

Venture Capitalist, US

06

The role for NGOs

Summary - the role for NGOs

- Some interviewees were very critical of the scrutiny and criticism that companies receive from NGOs and the media about their attempts to decarbonise. One gave the view that NGOs need to ‘back off’ and allow companies to make mistakes.
- Some interviewees highlighted that NGOs could plug information gaps - what is the total offtake commitment from airlines, testing the assumptions of SAF models, calculating what level of policy intervention is required to achieve a given percentage of SAF.
- A few highlighted that NGOs can be more effective at influencing governments and pointing to areas where stronger regulations are required. Both lawyers interviewed are particularly concerned by the lack of clarity around upcoming CORSIA penalties.
- A couple of Venture Capitalists referenced where philanthropy was already making big investments into green technology, but these are not yet big enough to help SAF producers scale.

One lawyer believes that public and NGO criticism hinders progress towards decarbonisation

"I can see all these people trying to do the right thing, but frankly, totally ignorant. Like people writing about decarbonising airlines. Airlines haven't got a clue. They don't have the money. There's about two or three airlines that are doing anything […and they] get bashed [… and] sued for ridiculous reasons. And then we end up nowhere. We end up in a situation where now airlines don't want to do anything because they're afraid of NGOs accusing them of greenwashing, which is absolutely horrendous. It's the worst place we could possibly end up is where NGOs are causing a totally perverse outcome. Not just in aviation but in industry, in terms of the climate action some corporates are taking. [… that results in] the owners and the people with the money not doing anything because they say, 'well, hold on a minute, our customers aren't doing anything. And in fact, they're discouraged by the media and the NGOs from doing anything because the moment they say something and do something, they're accused of greenwashing.' […] So, you all need to back off and let these corporates do what they're doing, and they can make mistakes and they can learn from those mistakes, and they can try harder and do better next time."

Law, Europe

"Why does the bashing put them off?

Because they don't want to be called out by the Guardian or whoever else. They don't want to be on the front-page news, why should they? Remember, a lot of this is voluntary action. There is no law. The reason why we have a voluntary market is because the law has failed. Public policy has failed. Governments have failed to put in place obligations on companies to actually decarbonise, right? So they take voluntary action and they make mistakes and that's OK. It's OK to make mistakes because they're learning."

Law, Europe

Scrutiny and criticism of offsetting makes it an unattractive investment

“The reason why [offsetting] absolutely will not happen is because airlines cannot say that the only way to decarbonise our sector is through offsetting. That is a death knell. To know the potential for aviation from a physics perspective, from a cost perspective, from an energy perspective - you should absolutely do that. It will not be done because the airlines cannot admit that the best way to do it, is in effect just to do offsetting.”

Venture Capitalist, Europe

Some investors wary of NGOs, and taking advice from NGOs

“I don't think you can use the stick on private investors because what you'll find is […] they're just going to say ‘that's just not for me’ because they have no interest in being told where to invest, how to invest. I think you'll find in the private investment world, whether you're talking about big institutional investors whose infrastructure investment arm is run by a team of 30 people, or you're talking about family offices, multi name family offices or even private equity owners, the stereotype of all of those people, I’m really sorry to say this, it rings true. They all think that they know everything, they've got no interest in being told ‘look you've got this wrong’. They've got no interest in being told ‘we're going to tax that more or we’re going to hit you with fees’. They're going to say ‘you’re going to sue me here. Great, I'm going to leave and I'm moving to Luxembourg, or I'm moving to Bermuda, or I’m going move to Delaware.”

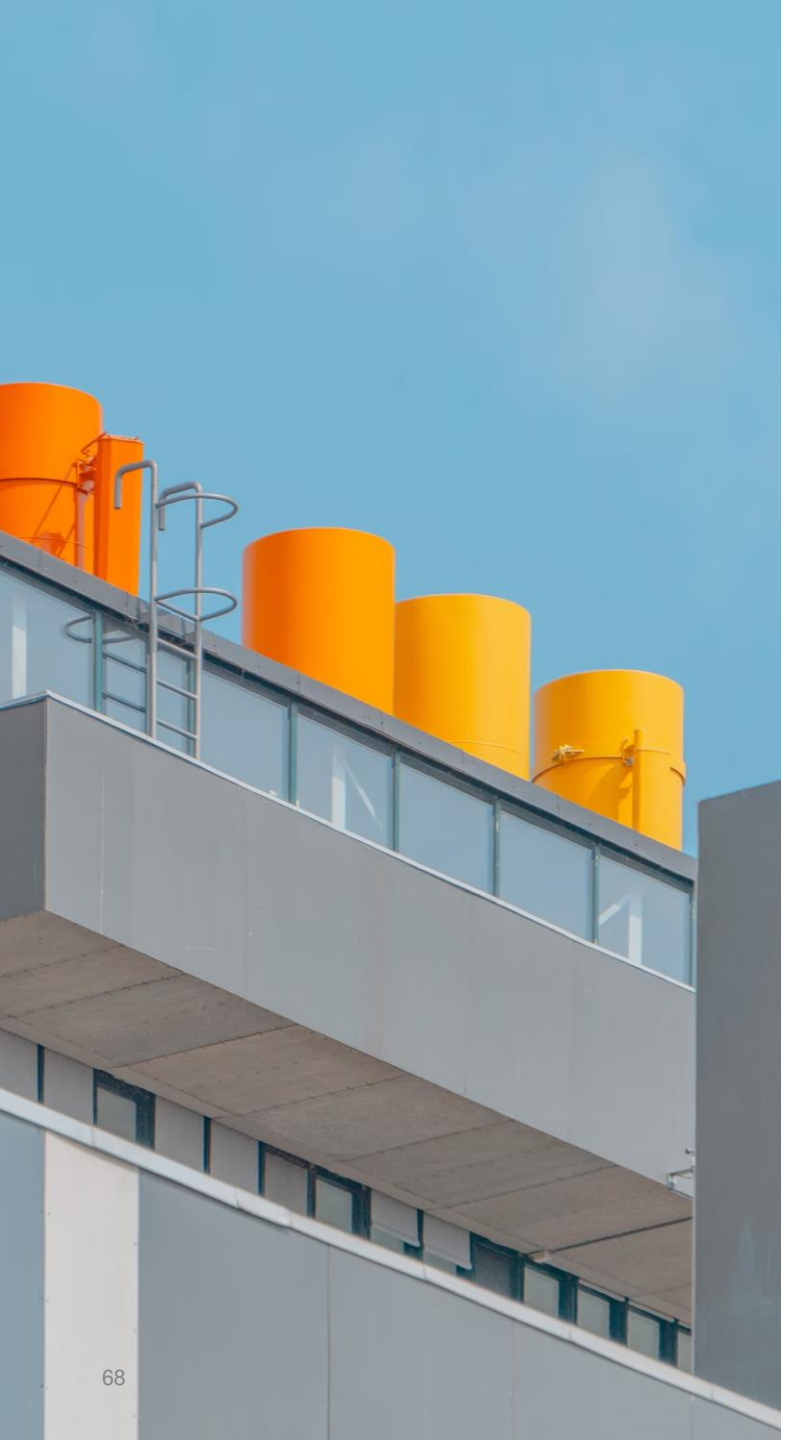
Institutional Investor, Europe

“[An NGO] wants to encourage the investment into synthetic SAF. Is that the right area for them? Is that where they can have the most impact in the aviation space? And how do they do that? […] The fundamental question is the first one, which is, is it the right area for an NGO to be encouraging investors? […] I don't think they need to. I don't see that […] is the best way for them to spend their time. There is plenty of incentives for investors to invest into SAF. Already everybody's aware that they need to be doing it. The problem is its cost of capital and project risk.”

Law, Europe

“I'd be skeptical [about taking advice from an NGO about investing], probably because I trust the industry. That's why we talk to them because they know what it takes to make it work.”

Venture Capitalist, US



But investors want to see NGOs pressuring governments on regulations

"From the charity perspective, yes, pressure on governments 100%. And then information to private investors of where they can put their money to work. If you can make someone else think that it was their idea in the 1st place, then they're going to be really keen to do it. […] Using the stick on governments, absolutely. I think pushing them for policy, particularly to help that funding gap, if governments are pushed into helping to subsidise that funding gap and creating public private partnerships."

Institutional Investor, Europe

"I don't know what their view on CORSIA is - that offsets are the only way that we get to net zero. And at the moment the scheme for creating eligible admissions units with corresponding adjustments is only slowly kicking off when people need to start retiring units by 27/28 for the first period. And then we're into the actual mandate period where the volume increases massively. I don't know if it's on their radar, but it's something that I talk about a lot because the industry will have a problem if there are no units available. And that so far, there's only been 7,000,000 produced and they've been bought by an oil and gas company. So, they're not available to aviation unless they're holding them to then sell later. If they're looking at how the transition happens, I would encourage a look at least on the carbon side to see whether there's anything encouraging that side of things as well."

Law, Europe

"I think advocacy is one - pushing governments to regulate industry, to use more SAFs and more clean tech solutions in general […] Both as consumers and as NGO advocates. Ultimately, companies do this because they think it's their best business interest to do so. […] We want companies to have to put real dollars and real intent behind adopting things."

Venture Capitalists, US

Some recommendations on helpful information from an NGO

“I guess for the investor audience it's the cost trajectory data or scenarios that are the most relevant. But for regulators or corporate audiences it could be interesting to provide some concrete recommendations [for example] ‘the IRA tax credit is this amount today, but we think that only actually scales SAF to 3% or 4% of the market by 2030. We need to double it or triple it.’ Some more concrete analysis on just how much regulatory support and what types would be required to scale the market would be interesting. And then anything around just tallying up all the corporate soft commitments to purchase SAF. I know United and Alaska Airlines and a lot of the other major airlines have made announcements on that front, but I don't know if I've seen a good compilation of like what the total potential demand looks like.”

Venture Capitalist, US

“Engaging experts is a way to further our deeper understanding of what the investment opportunity and risks might be. So, we would try and engage with NGOs such as Climate Catalyst, but also fund managers who have some experience that area. And then we typically put together some research papers and discuss the findings internally. And we come to a collective view that this represents an attractive opportunity […] Where possible, we typically try and engage with industry experts in the space. […] while it's important for us to understand the fundamentals around a particular industry and the science behind it, of course our predominant focus is on whether or not it represents an attractive opportunity for our clients from an investment point of view.”

Institutional Investor, Australia

Philanthropy already makes big investments into climate and SAF, but it is not enough to solve the biggest problem

"[Yesterday], someone mentioned that there was a trillion dollars available in philanthropic capital for climate and several of us went afterwards 'really? A trillion?' I do find that hard to believe. But I do see pockets of it. I see family offices and foundations, particularly for tech folks making grants and creative loans to companies. Several of them mentioned one because it's been publicised, Chan Zuckerberg initiative. They invest in a lot of health, much like Bill and Melinda Gates did. But Bill is obviously more focused on climate and Mark [Zuckerberg] wants to also do climate. So, they gave a grant to Twelve for example - 20 million. I don't want to call it a grant, I don't even know how it's characterised, but let's say creative financing of 20 million. They also did a carbon centre down at UCLA. We welcome that as our companies can really benefit from that because sometimes you need that to get to the next step [but] it's not necessarily going to solve the biggest problem."

Venture Capitalist, US

"Something where we would welcome this sort of engagement is that actually NGOs work with investors like ourselves in a way to actually invest in these underlying projects. And I think we don't necessarily need these institutions to be on the CAP tables because we also don't want to create an impression that projects are supported by NGOs […] So I think my advice would be for NGOs to work with institutions like 8090 industries to actually provide the capital that is needed to actually invest."

Venture Capitalist, USA

Thank you.

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