JUNE 30, 2021

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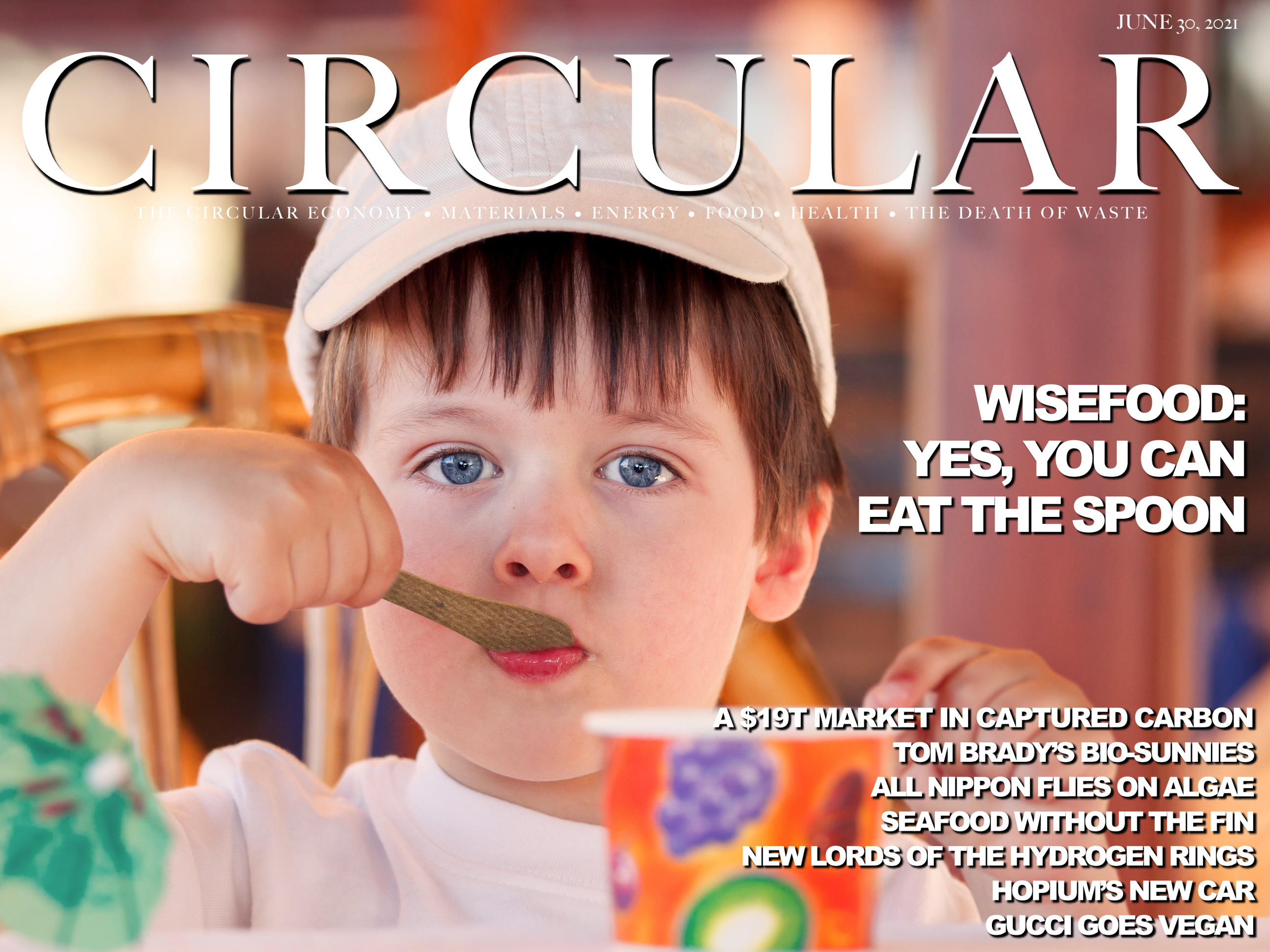

WISEFOOD: YES, YOU CAN EAT THE SPOON

A $19T MARKET IN CAPTURED CARBON

TOM BRADY'S BIO-SUNNIES

ALL NIPPON FLIES ON ALGAE

SEAFOOD WITHOUT THE FIN

NEW LORDS OF THE HYDROGEN RINGS

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6 CIRCULAR BREAKTHROUGHS OF THE WEEK

By Rebecca Coons

1

Sustainable apparel firm PANGAIA is set to launch an activewear line that incorporates numerous renewable materials while at the same time paying homage to the distinct, albeit occasionally regrettable, fashion trends of the 1980s. The line launches June 29 and is available for pre-order.

2

Sneaker giant Nike has introduced a new collection incorporating a pineapple-based leather alternative produced in the Philippines. The material—called Pinatex—is produced by United Kingdom's Ananas Anam.

3

Core One Labs has developed a process to make psilocybin biosynthetically, and says its process can produce psilocybin that is stereochemically identical to the naturally occurring psychedelic and at consistent concentrations.

4

Eco-friendly sneaker brand Allbirds is calling for more investment and innovation in natural materials. Meanwhile, Allbirds recently began a collaboration with Adidas for Futurecraft Footprint, which, at 2.94 kilograms of carbon dioxide equivalent, is believed to be the best carbon profile in the sneaker business.

5

Specialty chemicals giant Symrise AG has received an offer from Chr. Hansen Natural Colors A/S, now known as Oterra, to acquire its natural food coloring activities for an undisclosed sum. Symrise expects the purchase agreement to be signed in the coming months.

6

Biomason is making tiles and bricks out of bacteria to provide an alternative to cement, which is responsible for large amounts of carbon dioxide emissions. The process is similar to how coral grows, and the resulting material is about 85% granite from recycled sources and 15% biocement. “

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TOM BRADY BIO-SUNNIES

Sunglass company Christopher Cloos has added new styles to the biodegradable sunglass line it launched late last year with Greatest Of All Time quarterback Tom Brady under center as spokesman. The line focuses on classic shapes and designs and uses M49 Mazzucchelli, a bioplastic made in Italy and composed of cellulose acetate, in its frames.

The glasses also provide the light protection the ageless star requires as he adjusts to the sunnier climate in Tampa Bay—possibly made worse by the reflection off of the bling of his six Superbowl rings. "I have worn more sunglasses in the last twelve months than I have in my entire life," Brady told VOGUE recently. "It's sunny year-round, and then being out on the water—you need a great pair to protect your eyes from sun damage."





Did you know that industrial processes in the US consume more energy than the entire transportation sector? Within industry, chemical separations alone account for about **half of US industrial energy use.** Many separation processes can be significantly improved by using membrane-based solutions, that use up to **90% less energy***.

Of course, there isn't just one silver bullet that will solve the environmental challenge. By combining advanced technologies and processes, we can hit NetZero together.

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* Seven chemical separations to change the world, Nature, 2016

Membranes for a NetZero Future

PRODUCT OF THE WEEK: FISH WITHOUT THE FINS

Alternative seafood startup AquaCultured Foods claims to have produced the world's first "whole muscle seafood alternative" via fermentation. The process uses fungi to produce seafood substitutes for products like calamari, shrimp, whitefish, and tuna.

"Plant-based seafood is an area that has been notoriously lacking in options," says Anne Palermo, CEO and cofounder, AquaCultured Foods, tells vegconomist. "Identifying this lack of supply in spite of the overwhelming global demand has helped us to realize the market white space at hand."

The fungi grows like fiber threads, mimicking the texture of seafood. The startup is currently working to raise $1.5 million to launch in markets as well as bring a popcorn shrimp alternative to restaurants.

"As the first to create whole cut seafood alternatives via fermentation, the opportunity is almost limitless in the future food landscape," Palermo adds. "Any way that traditional seafood can be used, from raw sashimi to battered and fried popcorn shrimp, our seafood alternatives can be utilized as a 1:1 replacement."



GUCCI: LEATHER? WE'VE GONE VEGAN

Luxury brand Gucci has launched its first eco-friendly sneaker, featuring animal-free leather developed in-house. Dubbed Demetra, the material was developed at Gucci's Gruppo Colonna plant in Tuscany. It is 77% plant-based, using viscose, wood pulp and renewable polyurethane.



The sneakers also use organic cotton and recycled steel and polyester.

The name Demeter is a nod to Greek goddess of agriculture and harvest, Demeter. The kicks are available in Gucci stores as well as online, but they will set you back—prices start at €590 ($699).

The shoes will be available in three styles—Gucci Basket, Gucci New Ace, and Gucci Rhyton—and scraps from production will be reused and upcycled. Gucci is working to patent Demetra and add the leather alternative to other product lines such as handbags.







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Jennifer Stojkovic · 1st
Founder of Vegan Women Summit | Tech Policy | Host: VWS Pathfinders Po...
11h · Edited ·

Super exciting news out of California this past week with *another* #animalfree collagen & gelatin.

Advanced Biofuels and Bioproducts Process Deve...
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Adam Burja · 1st
Biotechnology | Innovation | DSM
20h · Edited ·

The consumption of fish has grown twice as fast as the world's population since 1961. #Overfishing has placed extreme pressure on wild fish stocks and is considered to be the main cause of #biodiversityloss in our oceans. In view of these environmental challenges, scientists from #Veramaris® - a joint venture of DSM and Evonik - have pioneered a sustainable solution: growing and harvesting natural marine algae, a high-quality source of omega-3 for aquafeed, replacing omega-3 fatty acids from wild-caught fish.

Bernardo Mendonça · 1st
New Business Development | Energy Transition | Advanced Biofuels | Carb...
1d ·

It's an immense joy to share that Raízen has just approved its 2nd commercial-scale cellulosic ethanol facility with an installed capacity of 82 million liters per year, thus consolidating as the largest producer of cellulosic ethanol globally.

William C. Bardosh · 1st
Founder and CEO: TerraVerdae BioWorks
1w ·

Major Milestone for TerraVerdae Bioworks. We have just launched field trials of our biodegradable agriculture mulch film at InnoTech Alberta's Vegreville research site. Looking forward to successful results over the summer! Thanks to,
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Canadian Federation of Agriculture,
National Research Council Canada / Conseil national de recherches Canada,
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NEW LORDS OF THE HYDROGEN RINGS

Oberon, Los Alamos get DOE support in the chase for the perfect hydrogen carrier.

Once-little Oberon is forging a ring of partnerships that may one day rule the world of green hydrogen.

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It may not have escaped your attention during visits to the opera or watching the Lord of the Rings trilogy on Netflix that there's, er, this ring, which grants the holder the power to rule the world. You might not quite recall that the ring was forged by Alberich, and that the name Oberon is a derivative of that that pops up in Burgundian medieval literature. In any case, what you need to remember is that Oberon fashions a ring with the power to rule over all, and gets chased around quite a few opera epics because of it.

Another Oberon, this one Oberon Fuels, has been fashioning a ring of its own, a ring of partners, from the Potentates of propane to the tycoons of trucks, and lately, Los Alamos National Labs and the US Department of Energy have joined the tribe as it seeks to redefine the way we move hydrogen around.

The problem being of course that pure hydrogen is a gas, mighty flammable, and it's bulky and tricky to move around, unless you compress it, which chews up carbon and adds cost. Of course, hydrogen's found in a lot of solid materials, like table sugar, and liquids such as water and gases like methane that are easier to transport.

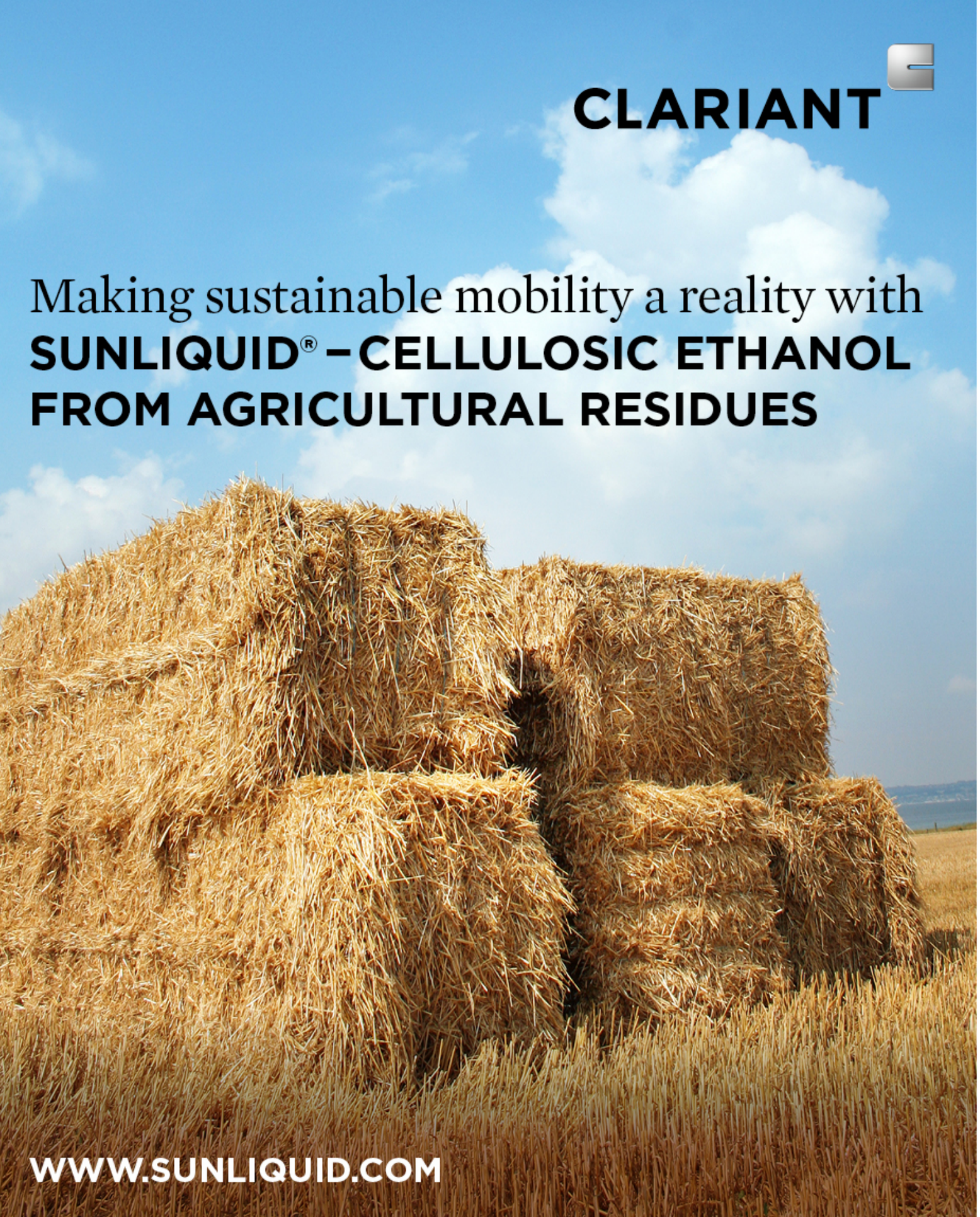
One pretty terrific carrier is DME fuel, which is about 12 percent hydrogen by weight, and handles like propane. So, a project that could figure out how to strip hydrogen out of DME is going to have fans in the world of hydrogen, and if you can made renewable DME, you can make green hydrogen. Pretty spiffy.

This week, the U.S. Department of Energy announced over $30 million in federal funding, matched by over $35 million in private sector funds, for 68 projects that will accelerate the commercialization of promising energy technologies—ranging from clean energy and advanced manufacturing, to building efficiency and next-generation materials.

And a public-private partnership between Los Alamos National Laboratory (the Laboratory) and Southern California-based Oberon Fuels secured f$1.5 million of that to scale-up steam reforming technology to produce renewable hydrogen from renewable DME.

It's part of DOE's "H2@Scale" initiative to accelerate development of a hydrogen economy by funding advanced-technology research, development and demonstration (RD&D) with industrial partners.

DME is a hydrogen-rich molecule that can be produced from waste and/or renewable resources using Oberon's modular production technology. Because DME handles like propane/liquefied petroleum gas (LPG), it requires minimal modifications to the existing global LPG distribution network and leverages the expertise of its existing workforce. This project will produce the final step – technology that can convert rDME into rH2 fuel at the point of use.



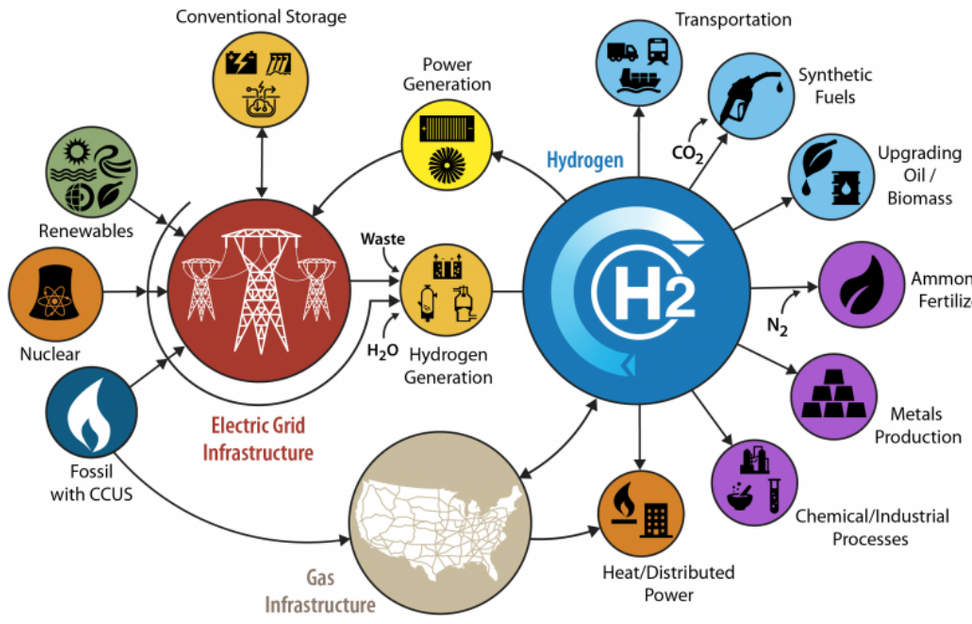
"Our novel approach to generating hydrogen flips the current model on its head," said Rebecca Boudreaux, Ph.D., President and CEO of Oberon Fuels. "We are producing a hydrogen-rich molecule, moving it using existing, low-cost infrastructure, and converting it to hydrogen fuel on demand. We are thrilled to partner with Los Alamos National Laboratory and the Department of Energy to meet Secretary Jennifer Granholm's vision for a hydrogen economy."

This project builds on a previous "bench-top" demonstration of a DME steam reforming process conducted by researchers at the Laboratory, which produced 0.018 kg of hydrogen per day. The goal is to boost production to 25 kg per day—a greater than 1,300-fold increase in hydrogen production capacity. The modeling and experimental outcomes of this project will be used as the foundational underpinnings to further scale the process from 25 to 500 kg of renewable hydrogen per day, which exceeds what an average hydrogen filling station currently uses per-day for light-duty vehicles.

"Based on the guidelines for alternative fuels, the DOE requirements for hydrogen carriers, our own thermodynamics analyses, and our bench-scale proof-of-concept validation, we believe DME is ideally suited for the H2@Scale effort," said Troy A. Semelsberger, Ph.D., a Technical Staff Member at Los Alamos National Laboratory.

The Oberon Backstory

Earlier this month, Oberon began commercial production of the first-ever renewable DME in the U.S. at its facility in Brawley, Calif., using waste methanol from the pulp and paper industry. Other potential feedstocks include: biogas from dairy waste, food wastes, agricultural waste, as well as excess electricity and CO_2. **C**



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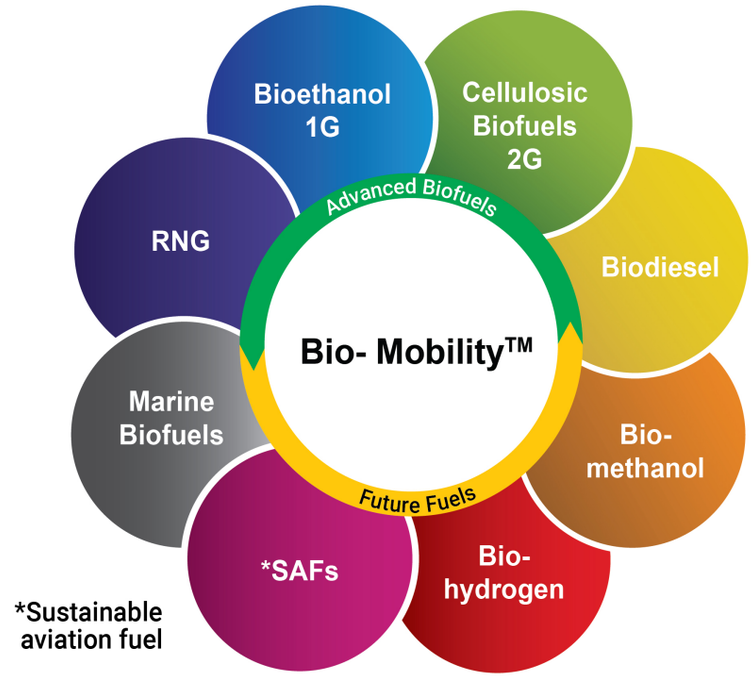

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TAX CARBON CONTENT, NOT EMISSIONS

A tax on fossil carbon is more effective than a tax on CO2 emissions, says Nova Institute

Christopher vom Berg, Michael Carus, Lara Dammer, Tatevik Babayan, Olaf Porc, nova-Institute

In light of increased efforts towards climate neutrality by 2050, the European Union (EU) is working on the implementation of a so-called carbon border adjustment mechanism (CBAM), which would put a carbon price on imports of certain goods from outside the EU. In our most recent publication, nova-Paper #15 "A Tax on Fossil Carbon is More Effective Than a Tax on CO2 Emissions", the nova-Institute introduces and discusses the realisation of the CBAM as a tax on fossil carbon. The proposed fossil carbon tax is a simple, effective and elegant tool to achieve the goals of the carbon border adjustment mechanism. It is in line with the ambitious climate goals of the EU and supports both the decarbonisation of the energy sector as well as the transformation of the chemicals and derived materials sector from fossil to renewable carbon.

At the National Renewable Energy Laboratory (NREL) we have noticed a similar trend within the bioenergy community. Go to any leading-edge conference (e.g., ABLC2021) and it is apparent that the number of innovative and transformative technologies is expanding rapidly.

With the introduction of the European Green Deal in 2019, the European Union committed to achieving climate neutrality by 2050. As a step towards this goal, the first European Climate Law – agreed upon in April 2021 – strengthened the emission reduction targets. In 2030, emissions are to be at least 55 % lower than in 1990. This will put the EU on track for climate neutrality by 2050 and for meeting its Paris Agreement obligations.

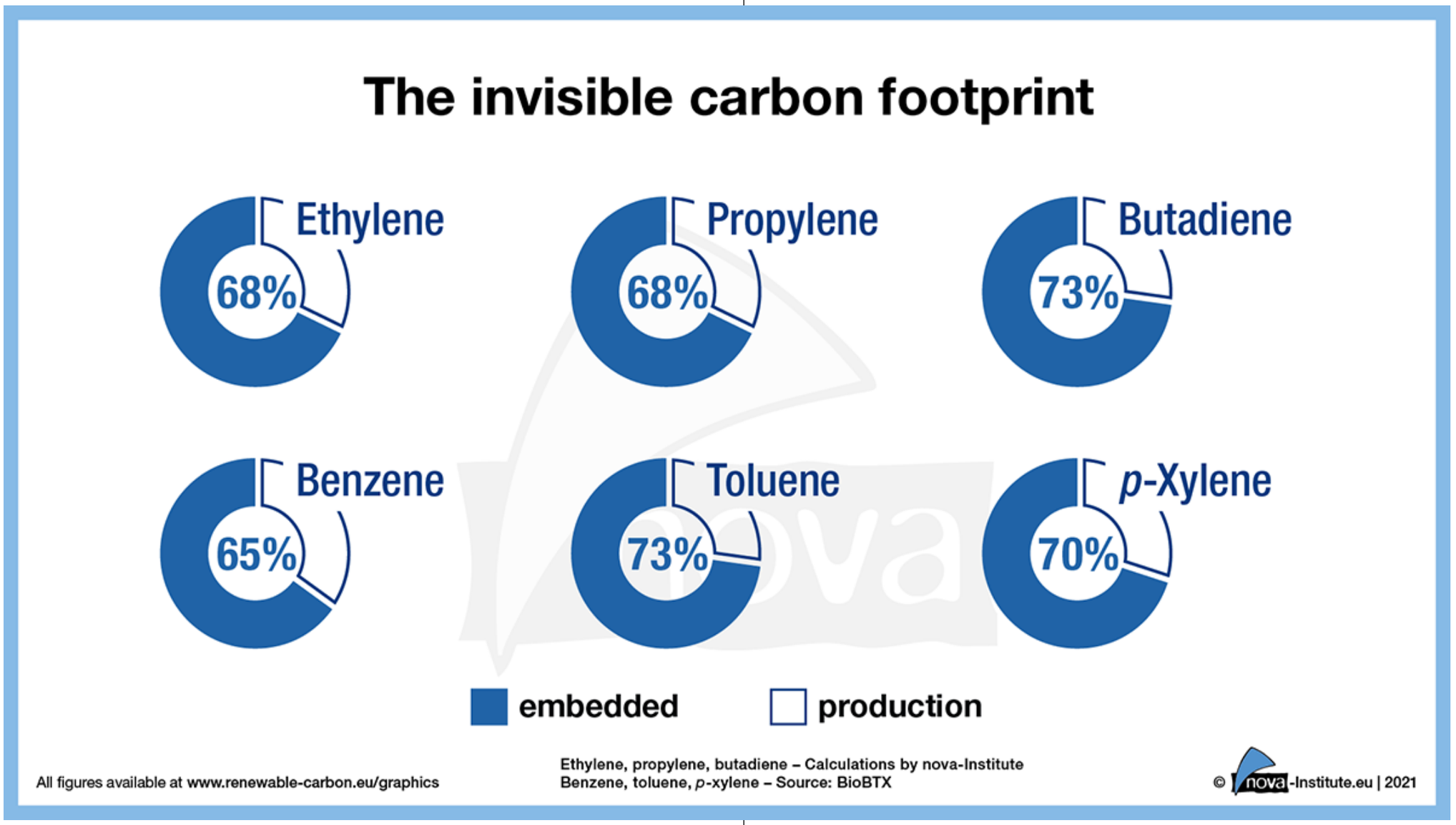


At nova-institute Christopher vom Berg is Deputy Head of Department Economy & Policy, Michael Carus is founder and director, Lara Dammer is Head of Department Economy & Policy, Tatevik Babayan is Project Manager and Scientific Associate, and, Olaf Porc is a Research Assistant.

Quite recently, there has been increasingly vocal support towards the CBAM to create a level-playing field for competitors importing into the internal European market and producing in countries that have set their sights lower than the European Union. In other words, goods imported into the EU would have to bear the same costs for carbon emissions as the ones produced in Europe.

The most frequently suggested option is to tax imported goods according to the greenhouse gases emitted during their production, most often referred to as a CO2 tax. In the new nova-Paper #15, experts from the German nova-Institute present a tool for elegantly pricing the true cause of global warming. A tax on fossil carbon at the feedstock level (called a “fossil carbon tax”) provides several advantages over a CO2 tax as an end-of-pipe measure. Carbon enters the economic cycle through the use of coal, oil and natural gas and is usually emitted as CO2 (after incineration) but can also be released into the atmosphere in other forms, e.g. CH4. With levying a price on fossil carbon, the cause of global warming could be priced elegantly, fairly, and universally.

nova-Paper #15 discusses the advantages of a fossil carbon tax in further detail. A fossil carbon tax solves a number of central issues considered a hurdle for the implementation of a CO2 tax, such as complexity, carbon leakage, eligibility to World Trade Organization (WTO) rules or taxation coverage of all sectors in the economy. The fossil carbon tax can be implemented regionally without endangering competitiveness, as a retroactive taxation or a reimbursement are possible on import and export.



With its focus on the raw materials, it is a much simpler approach than an end-of-pipe solution that looks at CO2 emissions. And a fossil carbon tax would not only encompass the energy sector but also cover the chemical and material sectors properly. In these sectors, the demand for embedded carbon will continue to increase in the future, and a fossil carbon tax would be a strong tool to work towards a comprehensive carbon management promoting renewable carbon.

The paper concludes that the proposed fossil carbon tax provides a simple, effective and elegant tool to achieve the goals of the CBAM and that is in line with the ambitious climate goals of the EU.

It is easier to implement and control than the CO2 tax covers all sectors that use fossil resources, ensures the continued competitiveness of the European industries, and will have a larger effect on climate change mitigation. All in all, the experts of the nova-institute are strongly convinced that a fossil carbon tax provides better incentives than a CO2 tax to progress from the use of fossil carbon to the utilisation of the three sources of renewable carbon: biomass, CO2 and recycling.

The nova-Paper #15 "A Tax on Fossil Carbon is More Effective Than a Tax on CO2 Emissions" can be found online at: http://www.renewable-carbon.eu/publications. C

When the future is at stake, **promises are not enough**

For over 80 years, Haldor Topsoe has been at the forefront of energy-efficient technologies, and now we are setting our sights on becoming the world leader in carbon-reduction technology by 2024.

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After all, progress is all that counts on the path to a sustainable future.

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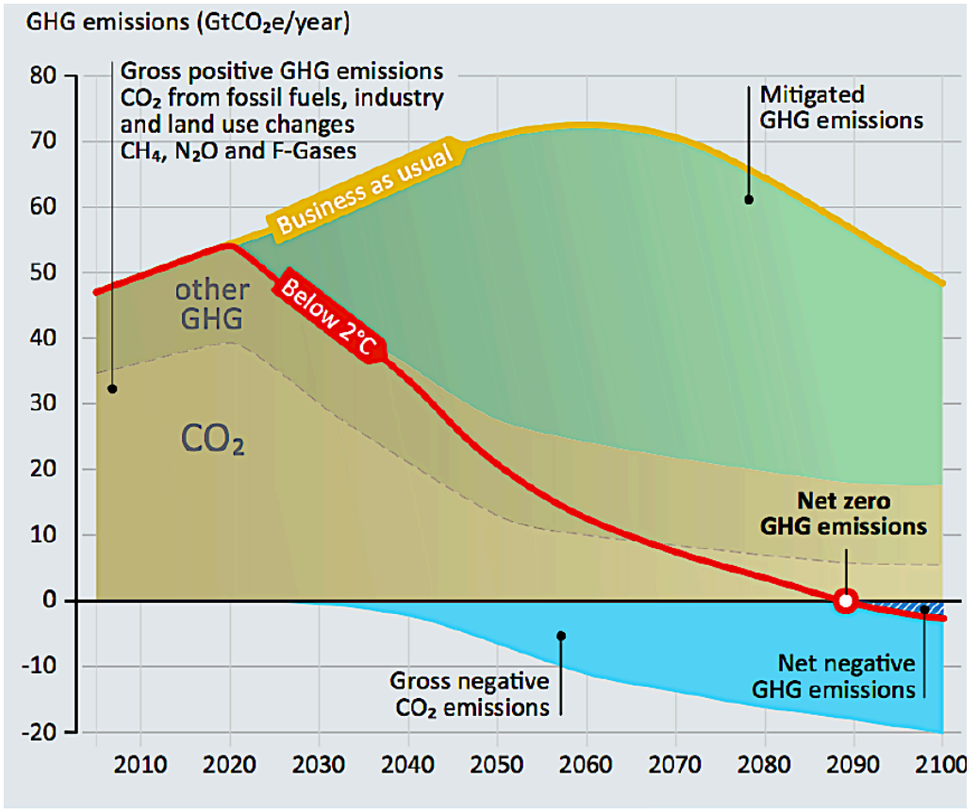
HOW WILL WE REWARD CARBON'S HUNTERS AND GATHERERS?

A $19 TRILLION MARKET IN CAPTURED CARBON LOOMS - TO WHICH VICTOR WILL GO THE SPOILS?

The IPCC forecast seen below tells the tale of how the next 50 years will play out in climate action. There's going to be a demand to remove 50 gigatons of carbon emissions through abatement (wind, solar, renewable fuels, energy efficiency, and so forth), and 20 gigatons per year through direct CO2 and methane removal. Assumes of course that when the Arctic melts that we wont have a catastrophic release of methane — a topic for another time.

First of all, let's do a value exercise. Adding up the carbon price in California these days, you get to $275 per ton, more or less. California has a market-based approach, demand and supply keep the exact number jiggling around a bit, but that's where it is, ballpark, these days. That's mostly for transport because most of the actual emission-reducing legislation has been aimed at transport for reasons of energy security as well as emissions.



With electric power the actual price support is harder to calculate. But consider the $981 price on carbon for electric vehicles — based on common-sense math which you can follow here. Point is, transforming electric stuff ain't cheap, either.

What's the carbon-reduction economy worth? 70 gigatons per year - that's 70 billion tons, is worth 19.25 trillion per year — that's 93 percent of the size of the entire US economy last year.

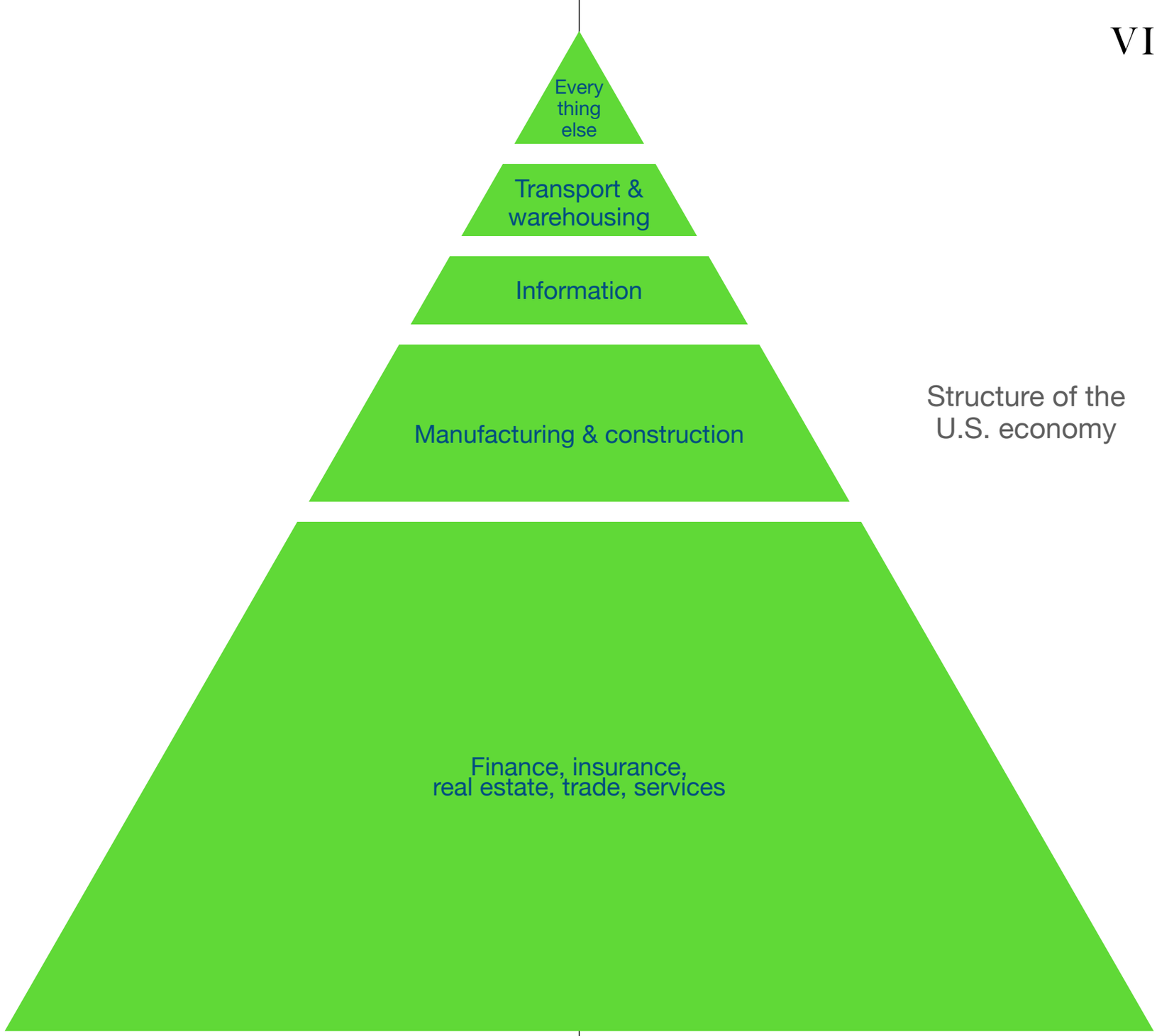
Time will tell how supply and demand will work out, so let's be circumspect. Yet, we can say for sure that carbon removal is going to be big business. So, you might do well by doing good.

But how?

Usually, we invest in technology, technology, technology… and then some more technology. Yet, manufacturing represents just 11 percent of our economy, and even if you subtract slices of the economy relating to government, education, health care, entertainment, food service and services unrelated to manufacturing, the pie still looks like this:

Finance, insurance, real estate	30
Professional services	17
Manufacturing	15
Wholesale trade	8
Retail trade	8
Information	8
Construction	6
Transport & warehousing	4
Utilities	2
Mining	1
Agriculture	1

From this, you might form a theory that a new sector of finance, insurance, real estate, services and trade might emerge in the remainder of this century worth $12 trillion per year in today's dollars. Without personally making or inventing a single thing, excepting the birth of the value-adding engine of services, finance and trade of the goods and services of the future. As I said, it's interesting, and speculative but not far-fetched.



Structure of the U.S. economy

I suspect we are conditioned to believe that technologists will rule the future and all power will transfer to them. I would only point out that Steve Jobs was not a technologist, and neither is Tim Cook for that matter. Neither is Warren Buffett nor Jaime Dimon, and I'm not too sure that Jeff Bezos is at the end of the day a technologist, per se. Bezos did not invent secure internet purchasing or machine learning but understood the consequences these innovations would have for the old bricks-and-mortar businesses of retail and delivery.

What is holding back climate action right now? It is not so much the technology. An acquaintance of mine who at the time headed up Wells Fargo's climate investing told me that the single biggest barrier to solving climate was the shortage of due diligence experts to evaluate the projects and the deal flow.

With respect to the value of finance, trading and logistics, consider a humble box of Corn Flakes. I just enquired at Amazon.com to discover the price, and it's running at 51 cents an ounce my friend, and there's about 0.7 cents an ounce in the corn, even though corn prices are sky-high at the moment.

So, where's the cost?

Manufacturing, yes. But also, in finance, insurance, trade and services. Sure, we see an awful lot of stories about tech billionaires and there seem to be a large number of them, but how many of them are actual inventors and how many of them are really financiers, traders or merchants, disguised as technologists through the branding, styling and communication that pertains to what we call "technology companies"?

You might well state that the value of Apple plays back to fundamental innovation, but another might state that most of it value is derived from packaging, integration, brand, and the network effects that flow from control of technology platforms.

Finance, trading, insurance, services. We're busy building technology and wondering why much of it is taking so long to become profitable,. or useful, or transformative. We never think that technology will invent itself, but we seem to believe that financial, risk, trading and service firms and platforms will appear like the blinding light that appeared to Apostle Paul on the Road to Damascus.

Will that be so? A student of Floridian insurance markets might be skeptical. Today, 548,716 Florida buildings obtain property insurance through Citizens Property Insurance Corporation.

The total insured value of the buildings covered is $148 billion, and the reason that Citizens exists is that traditional insurers, faced with the massive opportunities that climate change represents in the economy, exited the market, more or less.

Citizens is a creation of the Florida state legislature dating to 2002, has roughly $6 billion in cash to cover losses and there's another $10.6 billion in the Florida Hurricane Catastrophe Fund. Which is to say, Florida's fine until it's not, more or less the state is self-insuring.

Real estate is doing pretty well down here, and mortgages are flowing, too. Climate change has not brought about a transformation of the insurance or mortgage industry, yet.

Transformation of our financial systems is needed in order to assess risk, spread it, and to help create speedier rates of returns for investors that will justify the technology, policy, currency, market and adoption risks they are running. Altruism only takes society so far and though it is unpalatable to say "greed is good," it may be fair to say that "greed can lead to good". Certainly it is the case that small investors find it hard to run large and long risks, and will not be able to fully participate in a technology-driven shift of it takes too long or leads to losses that cannot be borne.



Nellis Air Force Base Solar Power Plant, Nevada

We need:

1.. Straightforward, system-wide carbon targets that tie back to societal goals.
2. A market system within those targets. Those who miss their goals buy credits from those who over-innovated.
3. A single standard by which we count carbon.
4 A book and claim system by which we report progress.
5. An audit system to vet those claims and root out the liars.
6. Carbon trading platforms which are as easy as trading stocks or currency, so that traders can participate and create liquidity in carbon trading.

70 gigatons. 50 to reduce, 20 to recapture. There's a lot of friction in the system and if we try to go fast the way we are structured, something will catch fire and burn. If we get focused on finance, that's one way of ensuring that what doesn't get burned is us. **C**

FLYING ON MICROALGAE

All Nippon Airways completes the first flight using ASTM-certified algae-based fuel

By Helena Tavares Kennedy

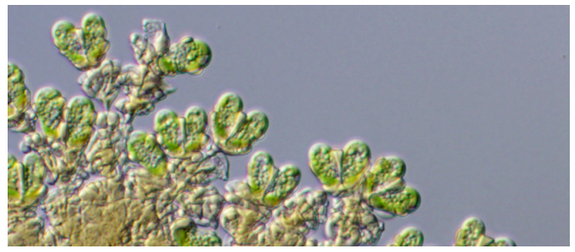
Another world first. All Nippon Airways (ANA), Japan's largest airline, took another step forward in advancing its leadership in sustainability, operating a regularly scheduled commercial domestic flight utilizing sustainable aviation fuel made from microalgae, blended with traditional jet fuel.

Yes, SAF made from microalgae. And it was the first flight in the world to use SAF certified to meet ASTM D7566 Annex7 jet fuel specifications.

The fuel

The SAF was produced by the IHI Corporation, based in Japan. IHI is developing microalgae (Hyper-Growth Botryococcus Braunii) and engaged in the next-generation technology development for mass-culturing fast-growing microalgae and producing fuel from algal oil produced by the microalgae consistently. This project, which started in FY2017, has seen the progression of algal culture tests in Kagoshima and Thailand (Saraburi Province), as well as the production of bio-jet fuel using microalgae as a raw material.

The fuel blend rate was 3.8% for this flight, according to ANA. As a drop in-fuel, it can be used in the operation of commercial aircraft around the world. And being the first flight in the world to use SAF certified to meet ASTM D7566 Annex7 it means they met the standard for alternative jet fuel for aviation defined by ASTM International. Annex7 defines a liquid hydrocarbon fuel obtained by hydrogenating crude oil (mainly hydrocarbon) extracted from the microalga Botryococcus braunii. IHI independently applied for the standard to ASTM and it was approved in May 2020.





TODAY IT'S POSSIBLE

GREEN CIRCULAR DISTRICT
THE NEXTCHEM MODEL FOR RECYCLING AND DECARBONIZATION

Maire Tecnimont

NextChem
Maire Tecnimont for Energy Transition

Decarbonize by recycling: today it's possible thanks to the **Green Circular District**, developed by NextChem, the Maire Tecnimont's company for energy transition.

The **Green Circular District** allows to **produce recycled polymers, chemical products, hydrogen** and **low carbon fuels**, through plastic recycling and recovering of non-recyclable waste.

The **model** is based on the integration of green chemistry technologies, as **Upcycling, chemical recycling** and the production of circular hydrogen and green hydrogen via **electrolysis**.

The **Green Circular District** brings benefits to the environment, economy and society, through decarbonization, recycling and recovery, production, employment and local economic development.

For a little more background, in 2019, ANA signed an offtake agreement with LanzaTech, Inc. to purchase sustainable aviation fuel, and expanded that partnership in 2020, giving ANA the opportunity to participate in fuel offtake across LanzaJet's global portfolio and production. In 2020, ANA and Neste, one of the world's biggest suppliers of SAF, entered into a SAF supply agreement, and together conducted the first flight out of Japan using SAF.
Together with Toshiba Energy Systems & Solutions Corporation, Toshiba Corporation, Toyo Engineering Corporation, Idemitsu Kosan Co.,Ltd., and Japan CCS Co., Ltd, ANA entered an agreement in 2020 to begin reviewing recycling business models for reuse of CO2 from sources such as exhaust gases into SAF. ANA supports activities within Japan led by companies such as Euglena Co.,Ltd. with its initiative to produce SAF since 2011.

The flight

ANA operated a domestic commercial flight on June 17, 2021 using SAF produced as part of project led by NEDO. SAF is expected to play a major role in reducing greenhouse gas emissions of aviation, and ANA will continue to work together with partners to construct a supply chain for SAF as part of its effort to contribute to large-scale commercial production in Japan.

Details of the flight:

Date: June 17, 2021
Route: Tokyo Haneda to Osaka Itami
Flight No.: NH31
Aircraft: Boeing 787-8

The forces behind it

The SAF fueled flight was realized in partner with the New Energy and Industrial Technology Development Organization (NEDO) - a prominent Japanese public research and development body – which aims to develop integrated production technology for SAF, with the IHI Corporation supplying SAF used on the ANA flight. The Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport and Tourism, and Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry Resources have led the initiative to establish and promote supply chains for SAF, bringing together related parties in the NEDO project.

Ryusuke Arashi, ANA Corporate Communications told The Digest in an exclusive interview, "ANA has pledged to become a carbon-neutral airline by 2050, with enhanced utilization of SAF being a key factor in achieving its ESG goals. ANA is committed to playing its part in pushing towards a sustainable future, and by working together with partners, ANA will continue to engage in development and transition to sustainable aviation fuel."

ANA has pledged to become a carbon-neutral airline by 2050, with enhanced utilization of SAF being a key factor in achieving its ESG goals. ANA's efforts have contributed to ANA being placed on the Dow Jones Sustainability World Index and ANA is also the only airline to receive the Gold Class rating in S&P Global's Sustainability Awards 2021. Under the ANA Future Promise initiative, ANA is committed to playing its part in pushing towards a sustainable future, and by working together with partners, ANA will continue to engage in development and transition to sustainable aviation fuel.

Neste's SAF progress

Speaking of Neste, they just announced that they delivered SAF to the Lone Star state, Texas. Just this past week, Neste and Signature Flight Support delivered commercial volumes of Neste MY Sustainable Aviation Fuel to Austin-Bergstrom International Airport (AUS) and Houston-Hobby Airport (HOU) in Texas, as well as the Norman Y. Mineta San Jose International Airport (SJC).

The low carbon, renewable jet fuel supplied to the two Texas airports came from a local refinery in Galena Park, Texas, where Neste is working with a Houston-based partner to safely complete the final steps of the sustainable aviation fuel processing operations.

"Sustainable aviation fuel is driving one of the biggest transformations in the business aviation industry that we've seen in a long time," says Chris Cooper, Vice President of Renewable Aviation for Neste in North America. "It's as impactful as the first Boeing 747 flight 40 years ago, which ushered in a new era of affordable air travel. Together, Neste and Signature Flight Support are creating a future where business aviation passengers can fly with a much smaller carbon footprint by revolutionizing what powers aircraft."

Neste and Signature Flight Support formed a strategic partnership to create an efficient, continuous supply of SAF for business aviation in the United States and beyond. Neste has been at the vanguard of sustainable aviation fuel production for nearly a decade and the company expects to have the capacity to produce some 515 million gallons of sustainable aviation fuel annually by 2023.

Recently, Neste and Signature Flight Support achieved the important milestone of safely delivering one million gallons of SAF to private aircraft at the San Francisco Int'l Airport.

Also just this past week, Neste and Boston Consulting Group (BCG) signed a new agreement for the purchase of Neste MY Sustainable Aviation Fuel, to be delivered to airlines SAS and Finnair, covering the volume of all the flights with these carriers taken by BCG employees in the Nordics. Through this new partnership, BCG expects to significantly reduce greenhouse gas emissions on flights with these airlines.

In early April 2021, Neste already made Neste MY Sustainable Aviation Fuel available to Finnair at Helsinki Airport to reduce emissions resulting from Neste's own business air travel. And now, BCG is the first corporate client of Neste that is benefiting from the same SAF-based solution for emission reductions.

BCG has committed to achieving net-zero climate impact by 2030, and supports efforts to scale up the adoption of sustainable aviation fuels to decarbonize air travel as part of its broader strategy to reduce emissions resulting from business travel. SAF is an important lever to reduce the climate impact of flying, and the use of Neste MY Sustainable Aviation Fuel offers up to 80%* reduction in life cycle greenhouse gas emissions (GHG) compared to conventional fossil jet fuel. Partnerships like this are an important step in scaling up the SAF market by sending a clear demand signal.

Bottom Line

Sustainable aviation fuel keeps taking off! The more we see these "world firsts" around the globe, the more SAF is here to stay and grow and make a difference for the future of sustainable aviation. It isn't about one feedstock or one airline but the innovation of many who collectively make a dent in improving things for all. **C**





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Or click here to learn more.

WISEFOOD

They make edible straws, plates and cutlery — and have turned one-and-done into a lifestyle statement.

So far, 170 nations have pledged to significantly reduce the use of single-use plastics by 2030. These plastic bans focus on items like that are often found in the environment instead of being recycled. So, what will we replace straws, stirrers and cutlery with? Why not edible versions? And while we're at it, cake pop sticks, chopsticks? That's what Wisefood's up to, upcycling apple fiber, to use an example, into a straw that lasts from 1-2 hours — and much more.

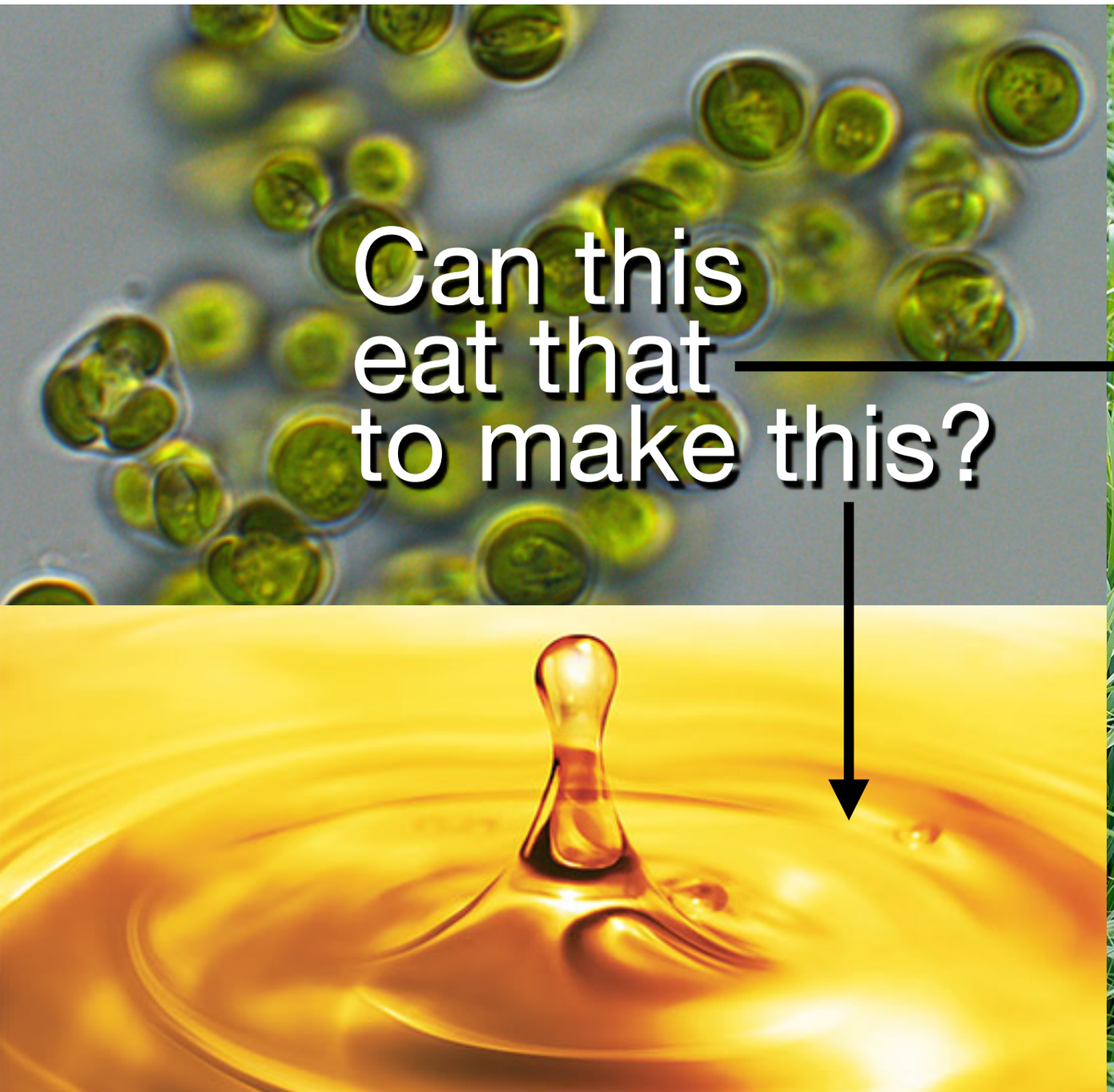
And, as these pages reveal, you can turn a personal commitment to the environment into part of your personal style. Who said the world's dine with one-and-done? You can learn all about them at wisefood.eu




Edible Straws
Essbare Trinkhalme
VEGAN
STRONG
BIODEGRADABLE
SUPERSTRAW
SUPERSTRAW

PROJECT LEAF: USING ALGAE TRAITS TO MAKE FUELS

In 2018, a group of researchers at Sandia National Lab reported the first example of degradation and utilization of whole native plant (for example, switchgrass) by a freshwater algae, *Auxenochlorellaprotothecoide.* In preliminary work, the team saw the same behavior in *Nannochloropsis*sp. with corn stover. Could a strain of algae actually “eat” terrestrial plants and produce useful biofuels in the form of microbial oils, at commercially relevant rates/ That’s what this 3-year project proposes to find out.





Project Overview

2

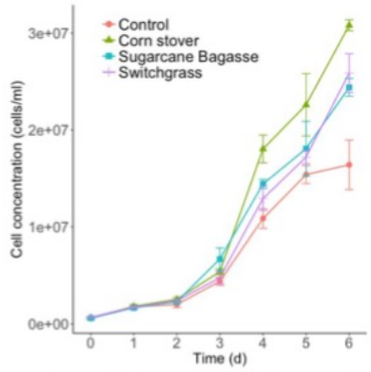
- In 2018, we reported the first example of degradation and utilization of whole native plant substrate (e.g. switchgrass) by a freshwater algae, *Auxenochlorella protothecoides*

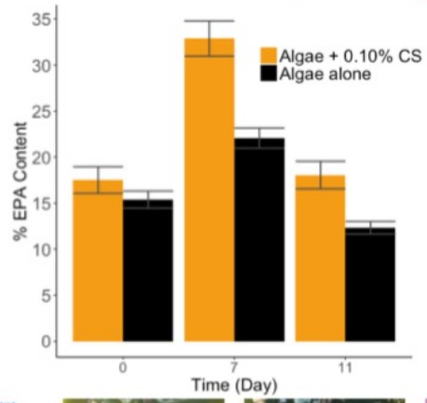
- In preliminary work, saw same behavior in *Nannochloropsis* sp. with corn stover, indicating this trait was more widespread than previously known. Biochemical pathway is unknown.

- Partnering with USDA, performed preliminary Scanning Electron Microscopy (SEM) to examine plant substrate with and without algae

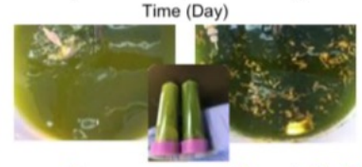
- Technical objectives by the end of the 3-year project:
  - Investigation of *Nannochloropsis* sp., *Picochlorum*, *Scenedesmus* and *Desmodesmus*, strains found to be top contenders for large-scale biofuel production by other groups.
  - Scale up and optimization of mixotrophic growth on plant substrates, demonstrating biomass and/or fuel yield improvement of 15% versus baseline (algae and plant alone).
  - Biochemical pathway mapping of plant substrate utilization in *Nannochloropsis* sp. and *Scenedesmus* sp.
  - Characterization of plant biomass changes after algae growth
  - Microbiome characterization in algae/plant substrate cultivation

Only group investigating biomass improvements with raw plant substrate. Other groups focus on hydrolysate sugars for mixotrophic growth.

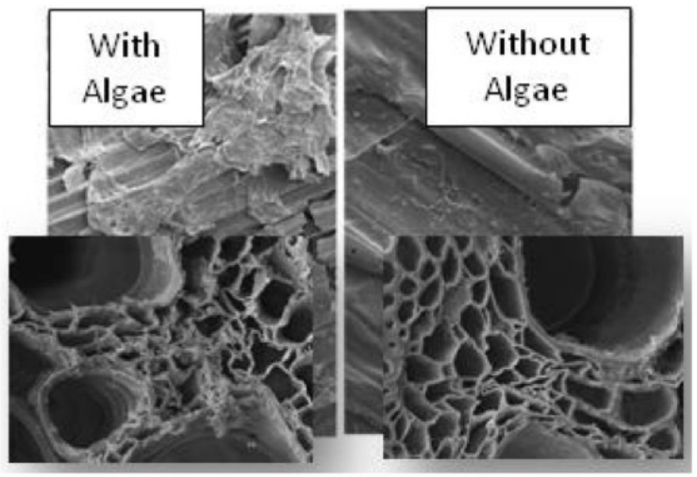




***N. gaditana* grown with corn stover increases biomass productivity compared to other plant substrates and algae alone.**



***N. oceanica* grown without (left) and with plants (right) at 50 L scale. Greener color with plants.**



SEM of corn stover with and without algae. Behind: Ripped epidermis and exposed parenchyma beneath in plants with algae. Forefront: Note collapsed cells and degraded cell walls of phloem in the treated plant. Also note the algae cells in the phloem.

I – Management

3

Los Alamos National Lab [Shawn Starkenburg and Jenna Schambach]– Strain growth (green algae), lipid analyses, and sequencing

Sandia National Labs (PI moved; Year 2-3) [Amanda Barry and Chuck Smallwood]– Strain growth (stramenopiles), biomass tracking, and examining the microbiome

USDA/U.S. Forest Service [Chris Hunt and Peter Kitin] – Plant substrate changes with algae growth

National Renewable Energy Lab [Jake Kruger and Nick Nagle] – Sugar recovery comparison with/without plant utilization

Industry partners:

Qualitas Health [Jake Nalley] – Consultation and scale-up support

Heliae Development LLC [Steven Pflucker] – Consultation and strain supply

Meetings every other week with LANL/SNL/USDA project teams. Frequent communication with NREL with timely delivery of samples.

Consultation with industry partners with regular data presentation.

2 – Approach

6

Strains and plant substrates to examine:

- *Nannochloropsis* sp. (multiple *gaditana* and *oceanica* strains), *Picochlorum*, *Scenedesmus* and *Desmodesmus*
- From Idaho National Lab Feedstock Library, corn stover, switchgrass, sugarcane bagasse
- From the Los Alamos EcoStation, yard waste (grass clippings and mulch)
- From USDA partner, stem and leaf sections

Determining productivity:

- Multiple scales
- Calculate growth rates by cell count and ash-free dry weight (AFDW)
- Quantify total lipids and lipid content by FAME
- Measure sugar recovery and yield with NREL protocols

Biochemical pathways involved in utilization:

- ^{13}C plant label tracking experiments
- Transcriptomic sampling at multiple timepoints

Effects on plant substrate:

- Examine plant structure with SEM
- Total sugar analyses before and after algae growth

Role of the microbiome:

- 16S analyses at multiple timepoints
- ^{13}C plant label tracking experiments



2 – Approach

7

Examine growth at multiple scales to meet productivity targets.

Flask experiments:

- Calculate growth rates of *Nannochloropsis* sp. (multiple *gaditana* and *oceanica* strains), *Picochlorum celeri*, *Scenedesmus,* and *Desmodesmus* with corn stover, switchgrass, sugarcane bagasse, and yard waste by cell counts
- Quantify total lipids and lipid content by FAME
- With top performing substrates, examine growth in the presence of CO_2
- ^{13}C plant label tracking experiments
- Sample for transcriptomic and microbiome analyses
- Send samples to USDA for SEM and total sugar analyses

50 L greenhouse raceway ponds:

- Examine top performing substrates and strains with and without CO_2
- Sample for transcriptomic and microbiome analyses
- Quantify total lipids and lipid content by FAME
- Send samples to NREL for sugar recovery comparison

700 L Qualitas ponds:

-Examine Qualitas strain with top performing plant substrate under usual industrial conditions

- **End of project goal:** Demonstrated biomass and/or fuel yield improvement of 15% versus baseline (algae and plant alone) in 700 L and larger ponds at Qualitas Health industrial site; Biochemical pathway mapping of plant substrate utilization in algae.

- **Go/No-Go (12/31/2020):** Demonstrated biomass and/or lipid yield improvement of 15% versus baseline (algae and plant alone) at 50 L minipond scale with at least 1 strain; Initial TEA of mixotrophic algae growth with plant substrate for fuel production shows an improvement over phototrophic growth alone.

3 – Impact

8

- If productivity targets are met, strategy could be employed immediately at industrial scale.
- Strains and plant substrates are selected for their industry relevance.
- Examination of productivity (both biomass and lipid) at multiple scales ensures relevance.
- Communication and consultation with Heliae and Qualitas Health, two companies with very different cultivation methodologies, throughout the project maintain our responsiveness.

Biology discoveries have impacts across the field:

- Redefining strain biology
- Microbiome dynamics
- Mapping alternative carbon substrate utilization
- Carbon storage under mixotrophic conditions
- Methodology for examining novel strategies at multiple scales

4 – Progress and Outcomes

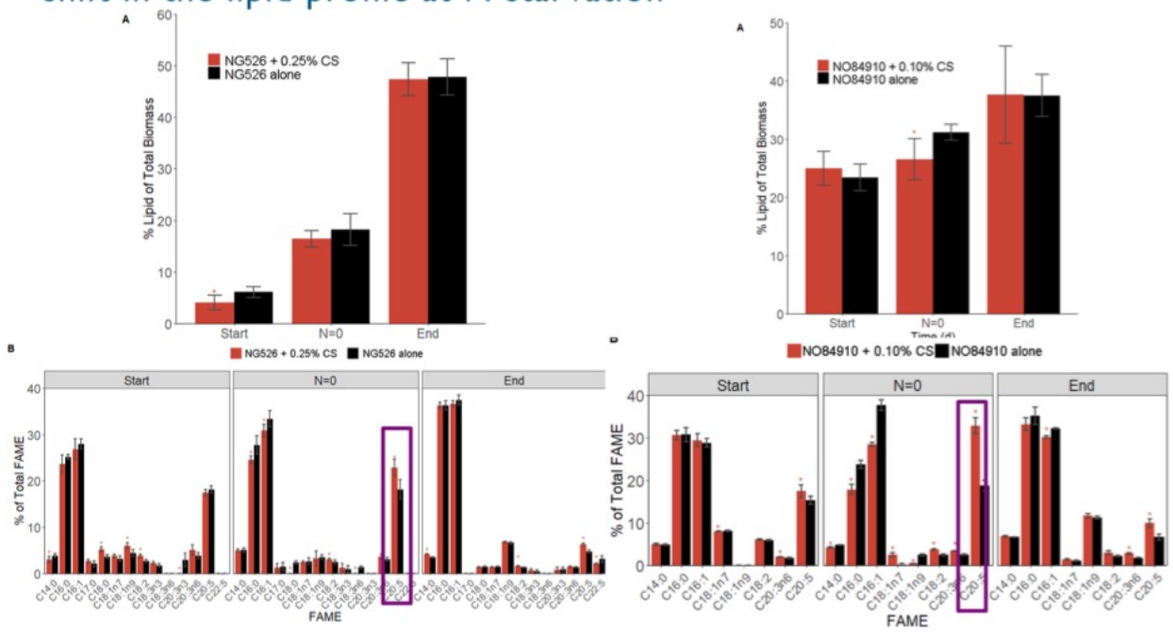
Major findings:

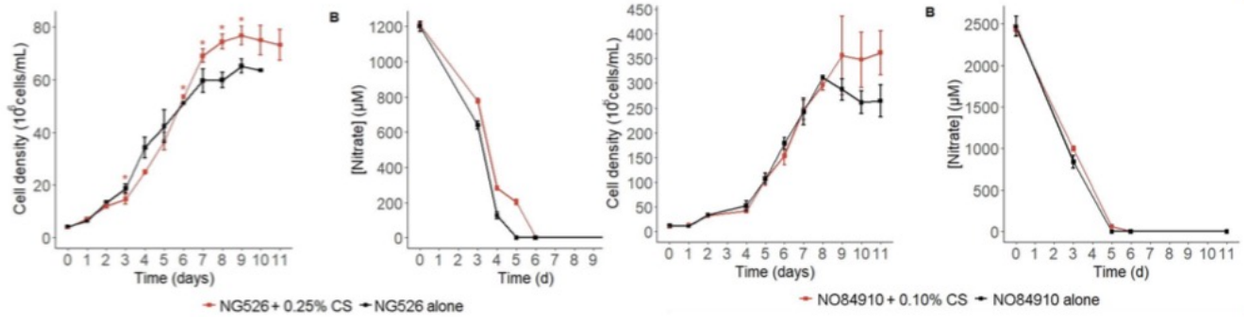
Nannochloropsis sp., *Scenedesmus*, and *Desmodesmus* all indicate biomass and/or lipid improvement with plant substrate addition at flask scale with one or more plant substrates tested. *Picochlorum* did not show improvement.

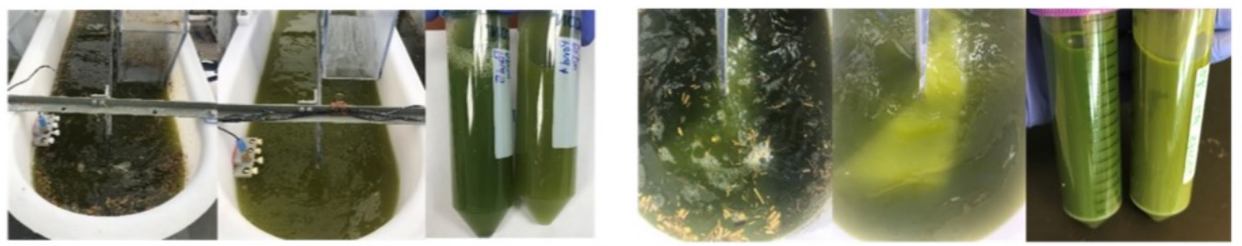
Scale-up of multiple *Nannochloropsis* strains showed mixed performance in 50 L raceways.

- With CO_2 input, biomass improvements are less significant than observed in flasks, while lipid improvements are generally maintained (increase in coproduct EPA); cultures appear greener in color over time
- AFDW of algae alone could not be calculated accurately due to algae colonization of the plant material even after washing.

Mini pond experiments show no difference in total lipids but a shift in the lipid profile at N starvation







Mini raceway outdoor pond experiments demonstrate improved growth for *N. gaditana* with plant substrates with a delay in N starvation

N. oceanica shows no difference with plant substrates at mini raceway pond scale

4 – Progress and Outcomes

Major findings:

Nannochloropsis sp., *Scenedesmus*, and *Desmodesmus* all indicate biomass and/or lipid improvement with plant substrate addition at flask scale with one or more plant substrates tested. *Picochlorum* did not show improvement.

Scale-up of multiple *Nannochloropsis* strains showed mixed performance in 50 L raceways.

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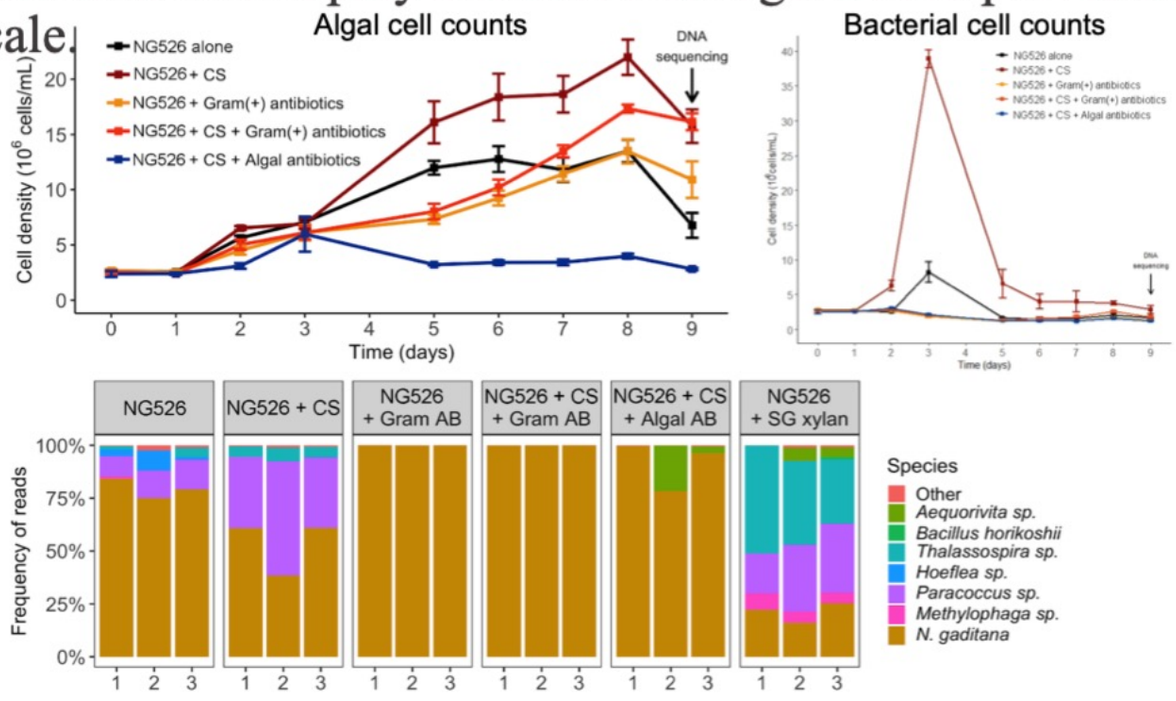
Microbiome dynamics indicate microbes play a role in initial growth improvements, but are not necessary for plant utilization at flask scale.



4 – Progress and Outcomes

11

Major findings:

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Scale-up of multiple *Nannochloropsis* strains showed mixed performance in 50 L raceways.

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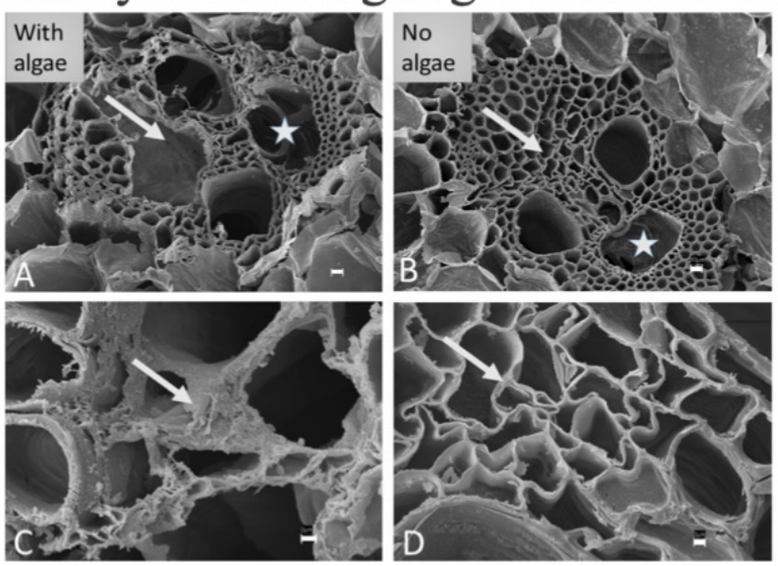
Microbiome dynamics indicate microbes play a role in initial growth improvements, but are not necessary for plant utilization at flask scale.

Plant substrate analysis after algae growth show structural and sugar content changes when compared to plant in media alone.



	Arabinan		Galactan		Glucan		Xylan		Mannan	
	Avg	95% C.I.	Avg	95% C.I.	Avg	95% C.I.	Avg	95% C.I.	Avg	95% C.I.
NG526 alone	0.0	N/A	54.6	18.6	49.1	37.3	9.0	8.6	16.0	11.4
CS alone	30.9	19.9	55.3	43.8	109.5	30.1	59.2	30.1	0.0	N/A
Sum	31.0	19.9	110.0	37.5	159.0	31.4	68.0	27.4	16.0	11.4
NG526 + CS	29.5	16.9	100.9	64.7	78.5	11.5	44.0	18.3	20.2	43.8
p value	0.797		0.656		0.002		0.051		0.716	

4 – Progress and Outcomes

12

Major findings:

Nannochloropsis sp., *Scenedesmus*, and *Desmodesmus* all indicate biomass and/or lipid improvement with plant substrate addition at flask scale with one or more plant substrates tested. *Picochlorum* did not show improvement.

Scale-up of multiple *Nannochloropsis* strains showed mixed performance in 50 L raceways.

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Microbiome dynamics indicate microbes play a role in initial growth improvements, but are not necessary for plant utilization at flask scale.

Plant substrate analysis after algae growth show structural and sugar content changes when compared to plant in media alone.

Transcriptomic sequencing, plant structure analyses in *Scenedesmus* cultures, and sugar recovery delayed due to COVID-19. Expect to be on schedule by end of fiscal year.

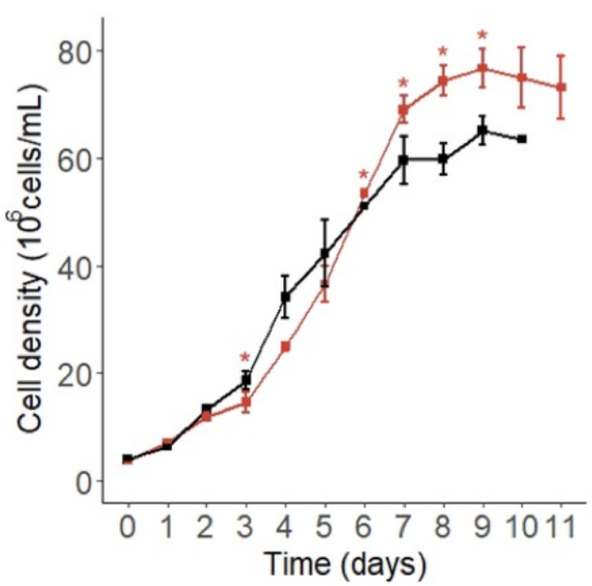
4 – Progress and Outcomes

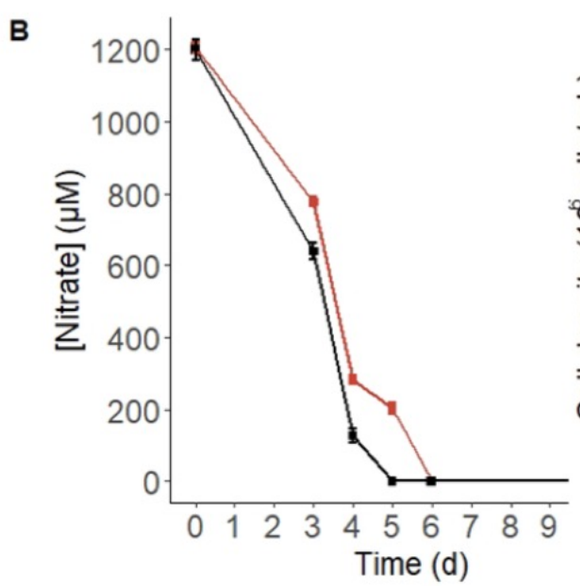
13

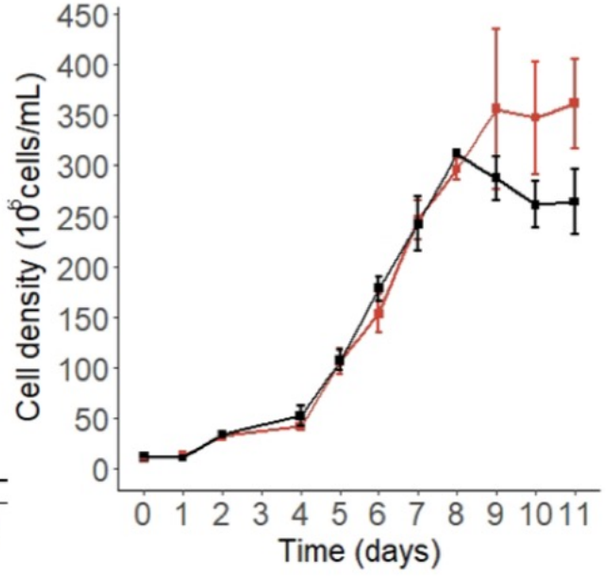
Go/No-Go (12/31/2020): Demonstrated biomass and/or lipid yield improvement of 15% versus baseline (algae and plant alone) at 50 L minipond scale with at least 1 strain; TEA of mixotrophic algae growth with plant substrate for fuel production shows an improvement over phototrophic growth alone.

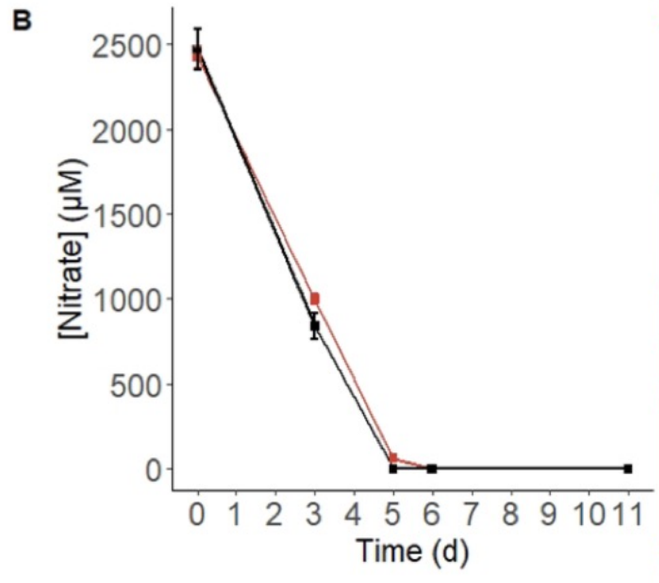
At 50 L scale with CO_2, the average specific growth rate for N. gaditana *cultures with corn stover (0.39 ± 0.02) was* ***30% greater than those grown without*** *(0.27 ± 0.02). This was statistically significant (p=0.0021). The average specific growth rate for* N. oceanica *cultures with corn stover (0.48 ± .04) was only 8% greater than those grown without (0.44 ± 0.04).*

*50 L experiments with other strains currently underway.









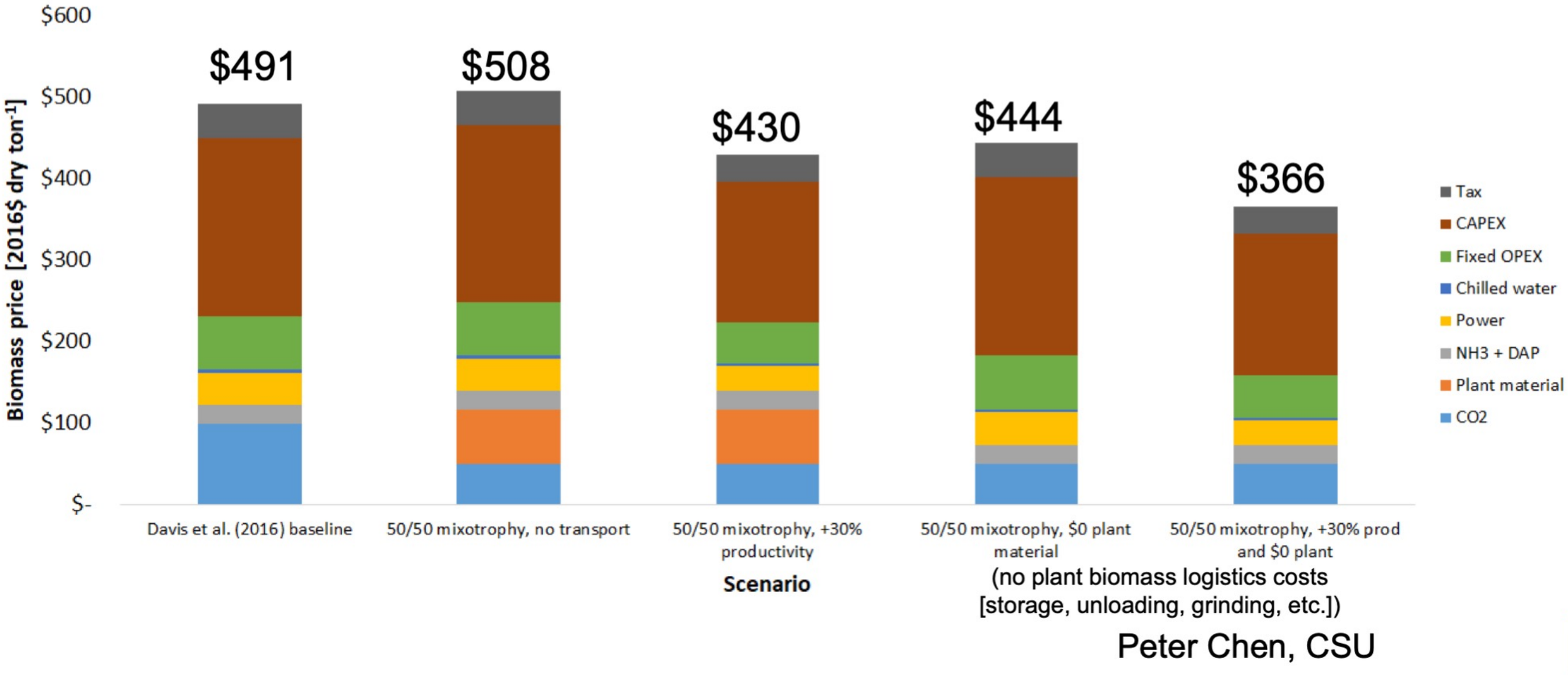
NG526 + 0.25% CS — NG526 alone

NO84910 + 0.10% CS — NO84910 alone

4 – Progress and Outcomes

14

Go/No-Go (12/31/2020): Demonstrated biomass and/or lipid yield improvement of 15% versus baseline (algae and plant alone) at 50 L minipond scale with at least 1 strain; **TEA of mixotrophic algae growth with plant substrate for fuel production shows an improvement over phototrophic growth alone.**



Peter Chen, CSU

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Summary

- Plant substrate addition to some algae strains (not all!) can result in improved biomass and/or lipid production.
- Productivity improvements can vary across scales.
- Algae utilize specific carbon substrates within the plant matter.
- The microbiome may play a role in substrate accessibility.
- Tracking the plant substrate carbon and transcriptomics will give a better understanding of algae biology and biochemistry.
- Industry partnerships are important to show technology applicability and relevance at large scales.
- Project is on-track with major milestones and should be up-to-date after pandemic delays by the end of FY21.

HOPIUM'S HYDROGEN CAR

Founded by Olivier Lombard, the youngest winner of the 24 Hours of Le Mans, Hopium is the result of his experience as a professional racing driver. The Hopium Māchina is the brand's first model, this platform was designed to meet the requirements of hydrogen technology in a high-end vehicle. Up front, the fuel cell system which integrates the stacks and balance of plant, generates the electricity needed to power the vehicle. The batteries, whose volume has been reduced as much as possible while maintaining optimal efficiency, contributes to Māchina's performances. The tanks allow a quantity of more than 6kg of hydrogen to be loaded for a filling time of only 3 minutes.

The performance? Impressive. More than 500 horsepower, 230 km/h and 1000 km of range.



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