INFER July / August / September 2022 Report

Will synthetic biology fundamentally transform the way the U.S. competes in the oil & gas industry?

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A forecast update for July, August & September 2022 highlighting a strategic question from INFER

Will synthetic biology fundamentally transform the way the U.S. competes in the oil & gas industry?

Status quo assumption: Synthetic biology is a relatively young field that has attracted both investment and support for the discovery science that is currently underway. If current trends persist, synthetic biology's overall impact to the oil and gas industry will continue to advance, with a comparatively smaller impact on industrial and commercial applications.

See Appendix C for detailed methodology

REPORT HIGHLIGHTS

INFER data from 9 forecasting questions (2 highlighted below) suggest that synthetic biology will contribute to incremental change in the oil & gas industry rather than fundamentally transforming it.

When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?

Forecast: 59% chance that a mention occurs by the end of 2023.

EXAMPLE RATIONALE SUPPORTING CURRENT FORECAST: ExxonMobil and Synthetic Genomics indicate that it has projected to produce 10,000 barrels per day by 2025. By 2024 they would already be producing and registering a part of their goal in their quarterly financial report. **(@Eliana, 9/28/22)**

See more details on Page 8

How many "venture capital members" will be part of BioMADE at the end of June 2023?

Possible Answer	INFER % Chance on 9/30
0	1%
1	34%
2	36%
3	29%

See more details on Page 22

INCLUDED IN THIS REPORT

395
FORECASTS

by

296
FORECASTERS

68% of Forecasters were INFER Pros

RECENCY
Good

81% of forecasts made or updated in the last 30 days

Forecaster Location:	
USA	55%
Canada, UK, EU, AUS	23%
South East Asia	8%
Central & South America	13%
Other	1%

Overview[1]

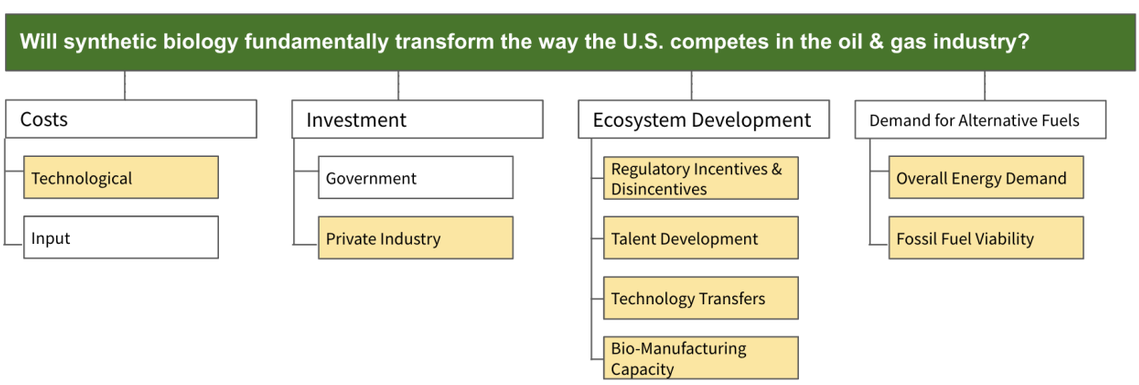
Synthetic biology is an emerging technical field that involves redesigning organisms for useful purposes by engineering them to have new abilities. Synthetic biology has applications in strategically important sectors for the U.S. economy. According to the US National Bioeconomy Blueprint (2015), synthetic biology and related biotechnologies have the potential to "allow [people] to live longer, healthier lives, reduce our dependence on oil, address key environmental challenges, transform manufacturing processes, and increase the productivity and scope of the agricultural sector while growing new jobs and industries."

However, the field is still maturing in terms of translating scientific discoveries into scalable products and solutions.. According to some experts, for the U.S. to remain competitive, one of the sectors that is close to commercial viability and could benefit from additional investment is the fuel industry. For example, synthetic biology can be applied to the production of biofuels, which are chemically similar to gasoline and diesel, but are produced by processing crops, algae, or microbial cultures. There has been growing international interest in alternative and renewable fuel sources due to increasing global energy demand, diminishing fossil fuel reserves, and the urgent need to mitigate greenhouse gas emissions from non-renewable energy sources. Synthetic biology has been touted as offering a potential solution to these challenges and it is already being used to produce biofuels, which are chemically similar to gasoline and diesel, but are produced by processing crops, algae, or microbial cultures. Companies are also exploring whether synthetic biology can replace the petro-chemicals found in everything from water bottles to yoga pants.

Tracking U.S. Progress With INFER

The fuel industry, in particular, is a sentinel case that both the government and private sector are watching to assess whether synthetic biology has the potential to fundamentally transform the bioeconomy and U.S. economic competitiveness more broadly while offering potential solutions to long-term policy issues in energy and climate change. This report uses forecast data to provide insight into the strategic question: **Will synthetic biology fundamentally transform the way the U.S. competes in the oil and gas industry?**

Below, you can see how INFER has decomposed this strategic question into four contributing factors (and related sub-factors) that are critical to understanding this question. The forecast questions in this report cover these factors and subfactors, providing a multifaceted view of the future of synthetic biology in the oil and gas industry. The sub-factors in yellow are ones that INFER has published questions on up to this point.



[1] https://www.infer-pub.com/the-pub/synthetic-biology-launch

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What percentage of the U.S.'s renewable energy consumption will come from biofuels in 2023?

"Biofuels" refer to the liquid fuels and components made from plant and animal materials, and the use of biofuels in the U.S. has typically grown each year since 1980 (EIA). Synthetic biology approaches can provide distinct advantages to biofuel production, including saving time and money, increasing yield, and enabling the production of new and better biofuels (GenScript).

Based on 97 forecasts by 61 forecasters:

Possible Answer	INFER % Chance on 9/30
Less than 20%	65%
More than or equal to 20% but less than 24%	31%
More than or equal to 24%	4%

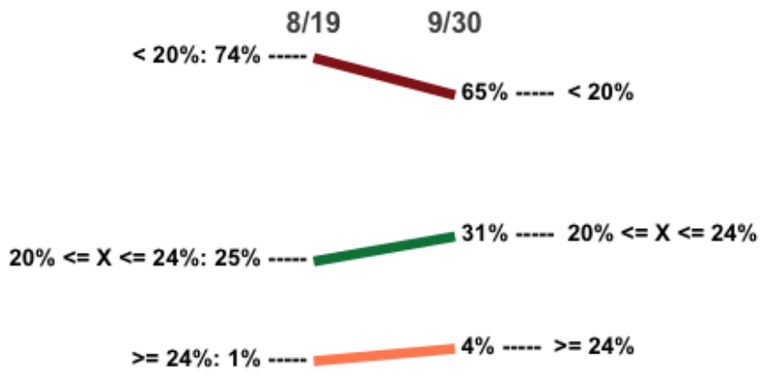
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

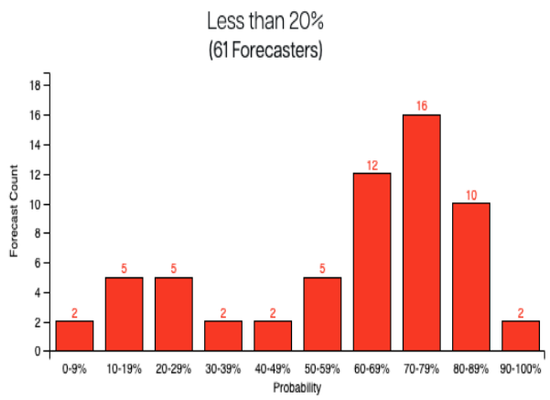
Less than 20%:	More than or equal to 20% but less than 24%	More than or equal to 24%:
▪ Without decrease in total renewable consumption, the lower this percentage the greater expansion of hydro, solar, and wind. This seems to be where the pressure is in the energy sector and from climate activists, so I don't think 2023 is likely to break 20% biofuel. (@Samantha, 10/2/22) *	▪ This statistic currently sits at an estimate of 22% of all US energy coming from biofuels in 2022. As such, I believe that technological developments will, as many fuel sources do, continue to become more efficient and widespread, but other, more "mainstream" power sources will also grow at a faster rate. (@nromero, 9/22/22) *	▪ Biofuels consumption has increased at an accelerated pattern even reverting to solar energy, which means the government sees more benefits on biofuels. According to the trend that started in 2005, the interest in biofuels has been increasing every year. (@Mauricio_B, 9/24/22) *
▪ After adding in the May and June numbers, I think getting above 20% is going to be difficult. Wind and solar keep rising, adding to the denominator. (@johnnycaffeine, 9/30/22) *	▪ Based on the monthly analysis of biofuel consumption in recent decades, it can be observed that there is no variation greater than 5% of the use in biofuels that exceeds 24%. (@ShamirS21, 9/14/22) *	

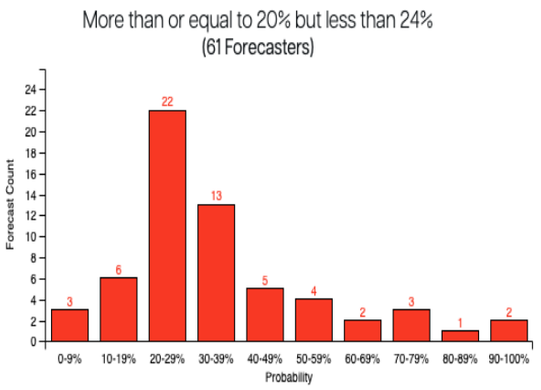
What percentage of the U.S.'s renewable energy consumption will come from biofuels in 2023?

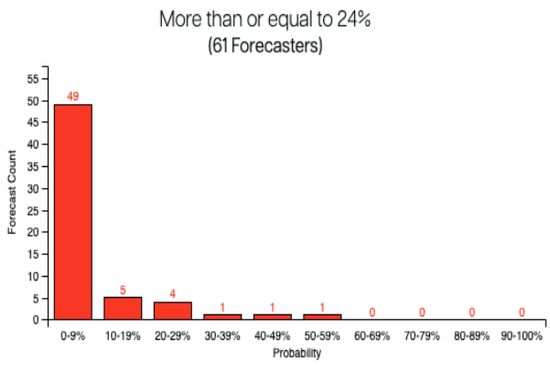
Consensus Trend (See the latest consensus trend here.)



Forecast Distributions (See the most up-to-date distributions here.)







When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?

ExxonMobil is partnering with synthetic biology firm, Viridos (formerly "Synthetic Genomics"), to scale algae-based biofuels (Bloomberg, Nasdaq). Algae-based biofuels were most recently mentioned in the 1Q 2018 Report, where ExxonMobil and Viridos (then "Synthetic Genomics") announced "a new phase in their joint algae biofuel research program that could lead to the technical ability to produce 10,000 barrels of algae biofuel per day by 2025."

Based on 50 forecasts by 29 forecasters:

Possible Answer	INFER % Chance on 9/30
In 3Q 2022 or 4Q 2022	24%
In 1Q 2023 or 2Q 2023	18%
In 3Q 2023 or 4Q 2023	17%
Not before 1Q 2024	41%

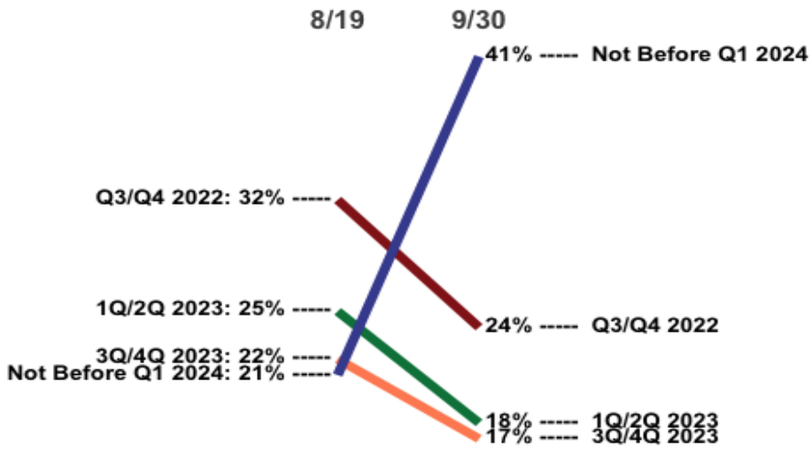
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

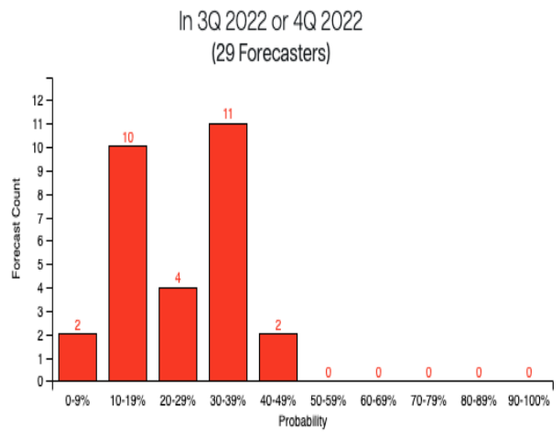
In 3Q 2022 or 4Q 2022:	In 1-4Q 2023:	Not before 1Q 2024:
▪ The switch to "green" energy has its merits, but there are limitations in implementing it at the scale that ExxonMobil may have in mind. Still, I think there will be favorable reports within the next quarter. (@bekahcha, 8/31/22) ▪ The first mention by Exxon of algae in a long time: https://twitter.com/ExxonMobil_UK/status/1562434453448052737 (@johnnycaffeine, 8/31/22)	▪ It doesn't cost Exxon anything to mention algae-based biofuels in any subsequent report, and since it gives them good PR, why not? That said, this partnership may not make the cut for the next report since it's already been announced. (@thsavage, 9/8/22) *	▪ExxonMobile and Synthetic Genomics indicate that it has projected to produce 10,000 barrels per day by 2025. In that sense, by 2024 they would already be producing and registering a part of their goal in their quarterly financial report. (@Eliana, 9/28/22) * ▪Adjusting based upon the inherent woefulness of results so far from algae to energy research. (@cmeinel, 9/22/22) * ▪ I'm estimating the mention of algae-based biofuels won't happen this year... also this article from last year in the WSJ paints a picture of this capability being slow to progress: https://www.wsj.com/articles/exxon-sees-green-gold-in-algae-based-fuels-skeptics-see-greenwashing-11633258802 (@vpsays, 8/30/22)

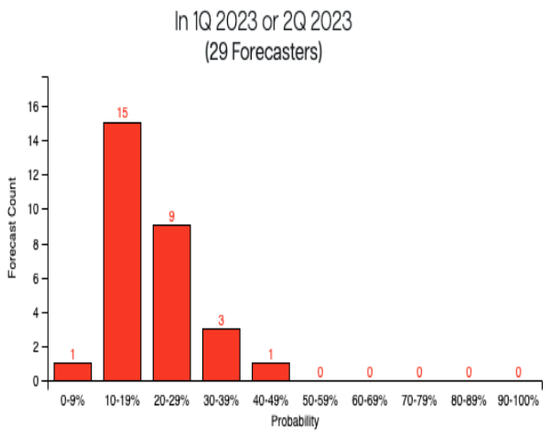
When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?

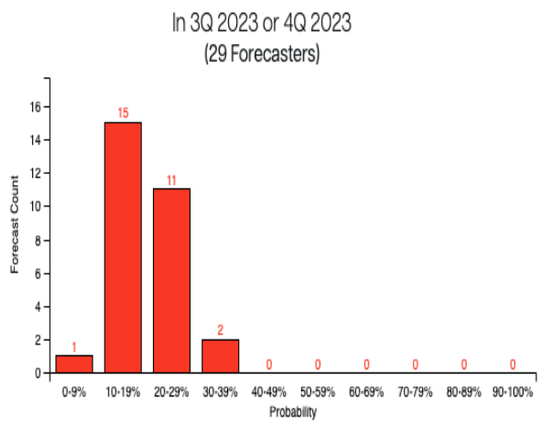
Consensus Trend (See the latest consensus trend here.)

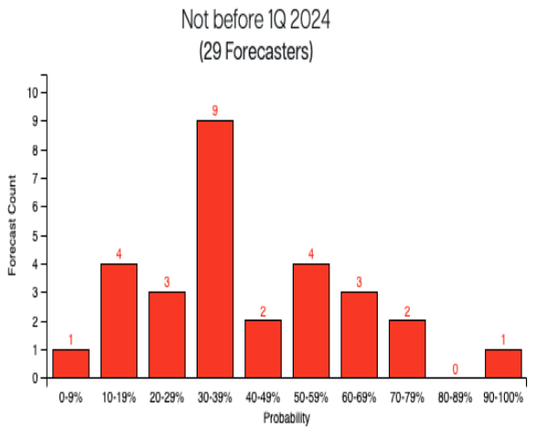


Forecast Distributions (See the most up-to-date distributions here.)









Will a top U.S. chemical or oil and gas company join the BOTTLE consortium as an industry partner by 31 August 2023?

Synthetic biology has shown promise both in breaking down plastics through enzymatic recycling and microbiome engineering as well as producing new bio-based plastics. Yet as the energy sector moves away from fossil fuels, oil and gas companies are increasingly looking to the production of plastics and other petrochemical products as a "plan B" (CNBC, Marketplace). The Bio-Optimized Technologies to keep Thermoplastics out of Landfills and the Environment (BOTTLE) consortium is a research consortium with the goal of developing new ways to break down, upcycle, and re-design plastics at scale. Currently, BOTTLE lists Amazon, KraftHeinz, The Ocean Foundation, and Patagonia as its industry partners.

Based on 13 forecasts by 11 forecasters:

Possible Answer	INFER % Chance on 9/30
Yes	67%
No	33%

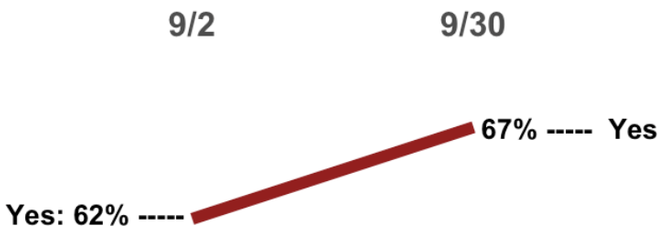
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

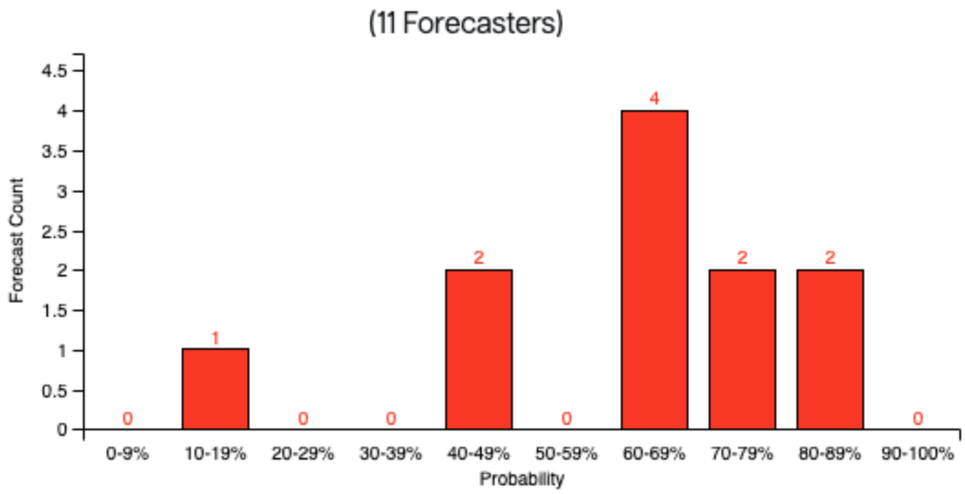
Yes	No:
▪ The winds are turning in the private sector on climate change and plastic pollution/petrochemical based products. Even if just for greenwashing, a top 20 oil or chemical company will likely join, especially one like Chevron working a lot on innovative technologies through its venture arm. (@coastbylight, 9/30/22) *	▪ From what I can tell, BOTTLE has no net benefit for any petro-chemical organization. BOTTLE is looking to create a circular thermoplastics economy. (@Mcowley, 9/30/22) *
▪ The recent policy developments in the US, e.g. the National Recycling Strategy gives an indication that industries need to shift from linear to circular models, including chemical companies. (@pschroder, 9/2/22) *	▪ These companies might have other interests that are not visible to everybody. (@Mauricio_B, 9/24/22) *
	▪ The fact that chemical companies did not join this consortium earlier would be a sign that they will not join it. I definitely see an alternative/similar consortium created by chemical companies for chemical companies. (@JJMLP, 9/4/22) *

Will a top U.S. chemical or oil and gas company join the BOTTLE consortium as an industry partner by 31 August 2023?

Consensus Trend (See the latest consensus trend here.)



Forecast Distributions (See the most up-to-date distributions here.)



How many U.S. teams will be named as a Winner or Runner Up at the 2022 iGEM Grand Jamboree in Paris?

The International Genetically Engineered Machine (iGEM) Foundation is an independent, non-profit organization dedicated to the advancement of synthetic biology, education and competition, and the development of an open community and collaboration. Performance at IGEM's Grand Jamboree, which includes competitions at the high school, undergraduate, and graduate levels, is often cited as a measure of progress for countries' synthetic biology workforce (NIH, Royal Society of Biology).

At the 2021 iGEM Grand Jamboree, winners and runners up across all categories came from Germany, France, China, the Netherlands, and Singapore. All past competition results can be found here. Winners and runners up have been named since 2016.

Based on 26 forecasts by 22 forecasters:

Possible Answer	INFER % Chance on 9/30
0	83%
1	15%
2 or more	2%

Summary of Forecaster Rationales (See Live Forecasts and Rationales)

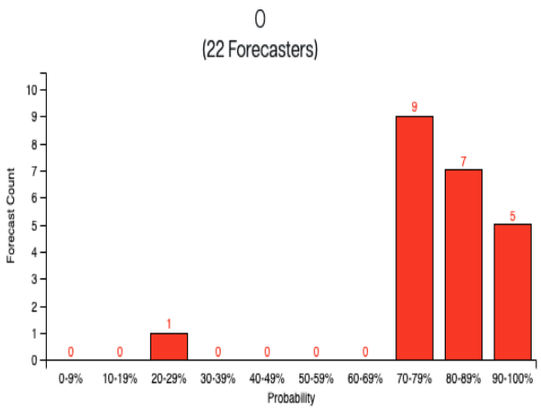
*** = Representative forecast rationales made in the last 30 days**

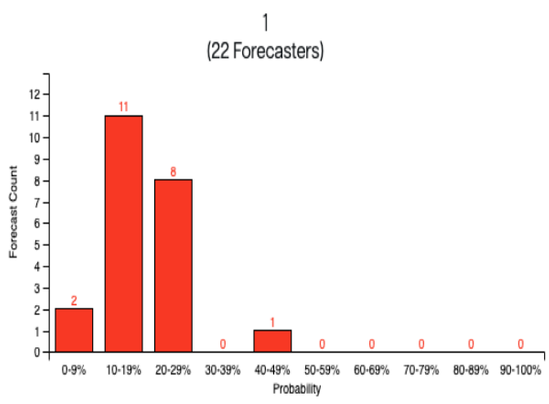
0:	1 or more:
▪ Looking at the jamboree results from the last 5 years, the last time a USA team was named as Winner or Runner Up was in 2018, with the UC San Diego team. Given that USA teams haven't been so strong recently, I think it is more likely that for the 2022 jamboree there won't be any USA team named Winner of Runner Up. (@DanAGS, 10/3/22) *	▪ Sometimes all it takes is one really dedicated student who takes ownership of a project and really gets into it for something impressive to get done, even as the rest of their team is essentially dead weight. (@Sulli365, 9/9/22) *
▪ The US has never won two awards at a single Jamboree, but I will apply a generous base rate to my first estimate and say there's a 1% chance that they will do so this year. (@Liflock, 9/9/22) *	▪ Synthetic biology is again becoming a US national interest due to the re-energized bio-economy focus by governmental organizations perhaps on the heels of the height of the Covid-19 pandemic and attention to biotech methods for detection, diagnosis, and vaccinations against the virus. Perhaps this focus will have drawn in more young people to STEM and synbio in particular. (@Multiminionnaire, 9/7/22) *

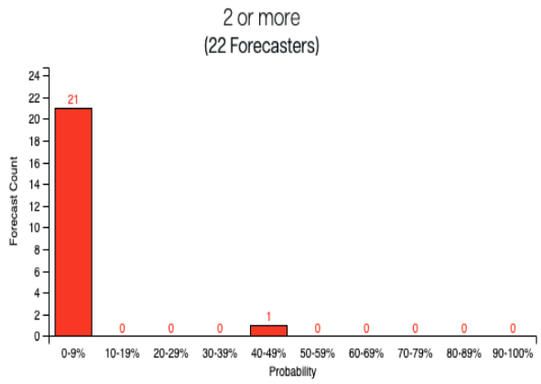
How many U.S. teams will be named as a Winner or Runner Up at the 2022 iGEM Grand Jamboree in Paris?

Consensus Trend (See the latest consensus trend here.)

Forecast Distributions (See the most up-to-date distributions here.)







Will the cost of sequencing a human genome drop below $100 before 1 September 2023?

Advances in DNA-sequencing technologies have dramatically expanded our ability to quickly and accurately engineer biological systems. As the cost of genome sequencing decreases, researchers can develop new applications that take advantage of this technology and use their understanding of genomics to manufacture cataloged DNA sequences and assemble them into new genomes. Having crossed the $1000 threshold in 2019, many are now eyeing the $100 genome as the next big milestone.

Based on 45 forecasts by 38 forecasters:

Possible Answer	INFER % Chance on 9/30
Yes	10%
No	90%

Summary of Forecaster Rationales (See Live Forecasts and Rationales)

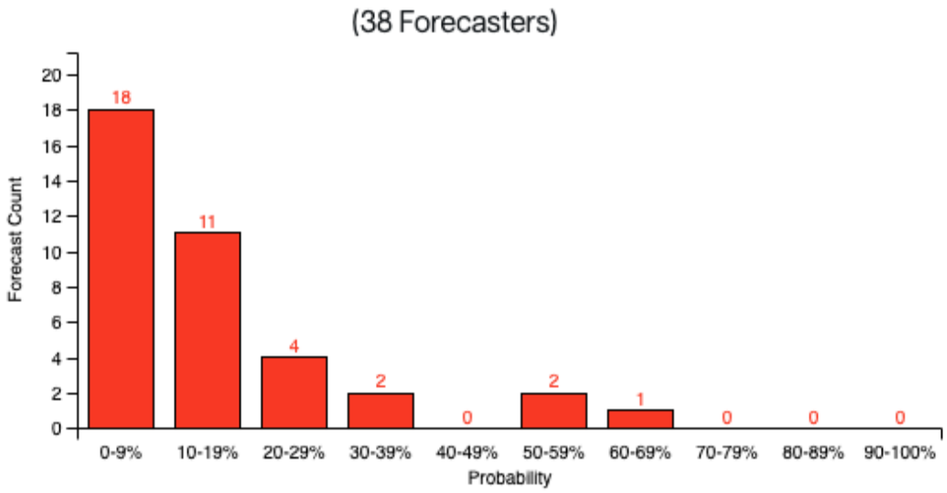
*** = Representative forecast rationales made in the last 30 days**

Yes:	No:
▪ Maybe someone will go with $99.99 as a marketing deal or something since I'm fairly certain we'll get to $100 by the end of Sept 2023. (@Coastbylight, 9/30/22) *	▪ If the available technology isn't well under $100/human genome already, and it's not, then given funding cycles, I don't see how the average cost/human genome for NHGRI-funded sequencing centers could be <$100 within less than a year from now. (@Belikewater, 9/30/22) *
▪ Advances in gene sequencing and the automation of the relevant laboratory processes could whittle down the total cost to $100 per genome. (@Adam6180, 9/19/22) *	▪ Even if we considering the recent variability, the lab costs are still very high. I really believe the price will reach $100, but only by early 2024. (@NickDCS, 9/29/22) *
	▪ If the current price trend holds, then this would still land well over $100. So for this to happen, some new company/technology would need to disrupt the current trajectory. (@ben, 9/16/22) *

Will the cost of sequencing a human genome drop below $100 before 1 September 2023?

Consensus Trend (See the latest consensus trend here.)

Forecast Distributions (See the most up-to-date distributions here.)



On 28 February 2023, how many states will be following the California emissions standard banning the sale of new emissions-producing vehicles by 2035?

In their ongoing effort to reduce the impacts of climate change, last month the California Air Resources Board (CARB) approved Advanced Clean Cars II which requires that all new passenger cars and trucks sold in the state be electric, hybrid, or otherwise zero emission (New York Times, CARB). California is the only state that can implement emissions standards that are more stringent than federal requirements (CARB, Environmental Protection Agency). Other states can opt to follow federal guidelines or California guidelines, and a number of other states are moving to adopt these more stringent standards (Fox Business, The Hill). Such moves are contentious and California's new standards are expected to be challenged in court (New York Times, The Hill).

As of 30 September 2022, Washington, Massachusetts and New York are now following the California emissions standard.

Based on 34 forecasts by 32 forecasters:

Possible Answer	INFER % Chance on 9/30
Less than 5	43%
Between 5 and 11, inclusive	23%
Between 12 and 17, inclusive	32%
More than or equal to 18	2%

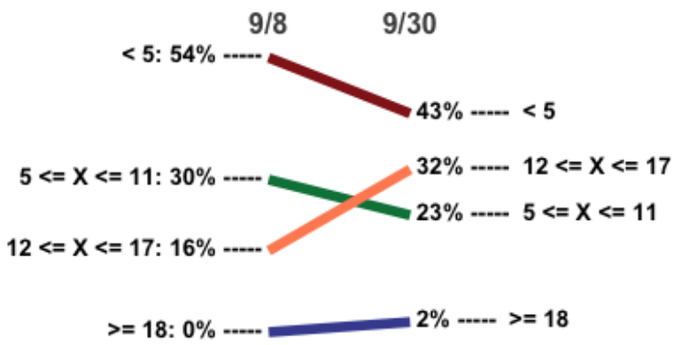
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

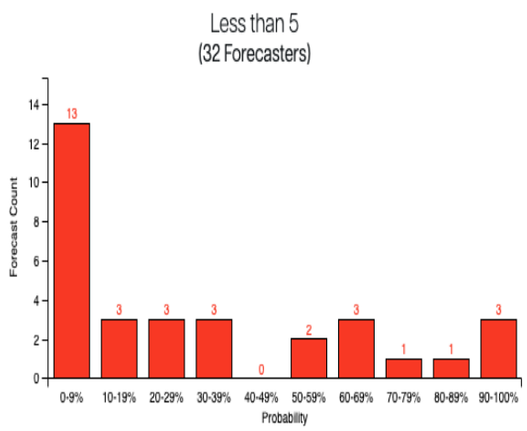
Less than 5:	Between 5 and 11:	12 or More:
▪ Many other states and the public will evaluate whether California's electric grid would be able to sustain this. (@estim-nation, 9/30/22) * ▪ There is a lot of anti-regulation fervor among the far right, and they control the majority of state legislatures now. Biden wants to show progress in climate control and this is an easy one for the Administration to push, but probably slow to promulgate on a state-by-state basis. (@Sepeskoe, 9/30/22) *	▪ There is a limited number of states with similar views to California on carbon emissions and the ability to act on these views in a significant way. (@BrookeCleveland, 9/29/22) *	▪ Currently, 15 have adopted the standard and three more are debating it. Assuming that no states will go back on the standard, this means we are looking solely at the top two buckets. (@Zev, 9/20/22) * ▪ My prediction is 13 states. I'll center my distribution around there and give some uncertainty, mainly in the negative direction. I think it's much more likely that less than 13 states adopt the requirements rather than more. (@MullenAustin, 9/8/22) *

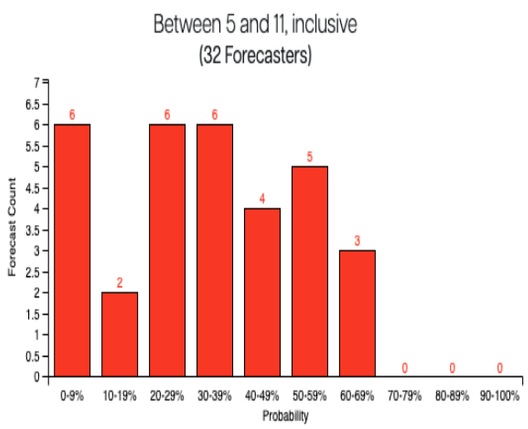
On 28 February 2023, how many states will be following the California emissions standard banning the sale of new emissions-producing vehicles by 2035?

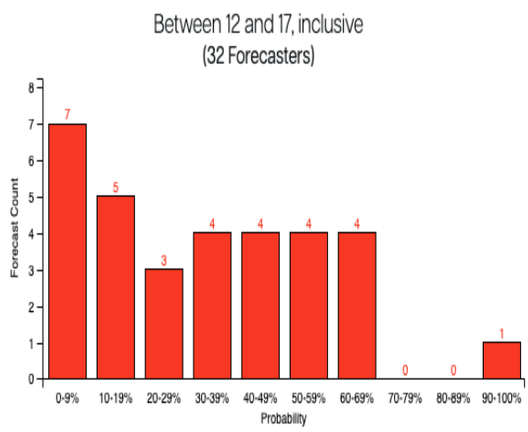
Consensus Trend (See the latest consensus trend here.)

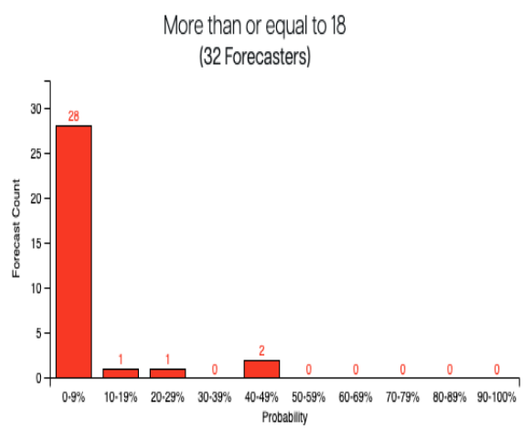


Forecast Distributions (See the most up-to-date distributions here.)









What will Ginkgo Bioworks foundry revenue be in the first quarter of 2023?

Scaling production of synthetic biology processes remains a key challenge (Institution of Engineering and Technology, Harvard Business Review). Ginkgo Bioworks foundry and codebase offers a platform to facilitate scaling both the research and production processes of their customers by programming and manufacturing cells on their behalf (Ginkgo Bioworks, Forbes, Nasdaq). These "cell programs" allow companies to manufacture food, pharmaceutical, and petrochemical products through biological processes (Ginkgo Bioworks).

Based on 17 forecasts by 14 forecasters:

Possible Answer	INFER % Chance 9/30
Less than $30 million	4%
More than or equal to $30 million but less than $45 million	9%
More than or equal to $45 million but less than $60 million	16%
More than or equal to $60 million but less than $75 million	34%
More than or equal to $75 million	37%

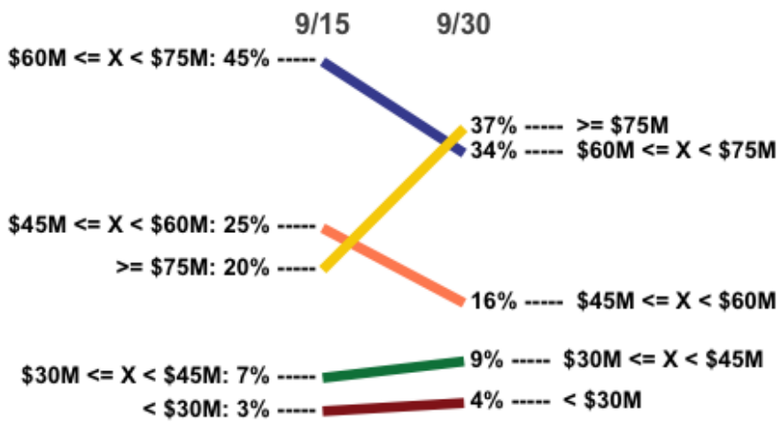
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

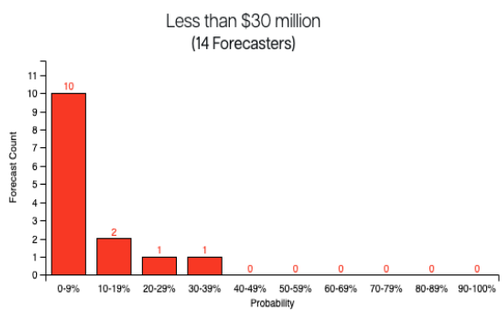
$60 million or less:	More than $60 million
▪ They benefited from a strong Q2 to get to ~$44 million in revenue. This is a jump in ~$20 million vs Q1 2022 and a higher number than many of their previous quarters. (@Sulli365, 9/21/22) *	▪ Ginkgo has gone through a rapid growth, going from $22M to $44M in a year. If we assume a linear trend, next year the revenue will be $66M. (@Sanyer, 9/29/22) *
▪ Given the current economic crisis it makes sense to bet that their revenues will be lower. However, in the most recent earnings season, Ginkgo was one of a minority of companies that didn't reduce full-year 2022 revenue and earnings guidance. This suggests they feel strongly about their ability to weather the crisis. These two effects together, essentially negating one another, suggest more stability in earnings. (@JamesB, 9/18/22) *	▪ Ginkgo has shown strong growth recently and seems well-positioned to keep up the momentum. Few historical data points but I will assume continued linear growth. (@Liflock, 9/29/22) * ▪ The evolution has been favorable to see a steady increase, I'm expecting to stay in the current range with an overall increase year-year. (@Ansantillan, 9/22/22) *

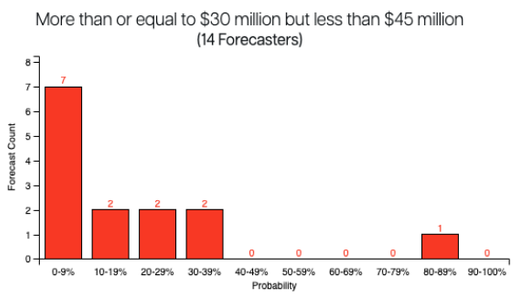
What will Ginkgo Bioworks foundry revenue be in the first quarter of 2023?

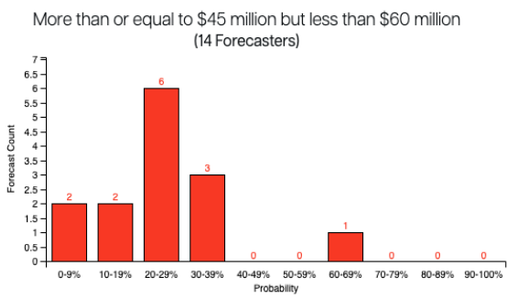
Consensus Trend (See the latest consensus trend here.)

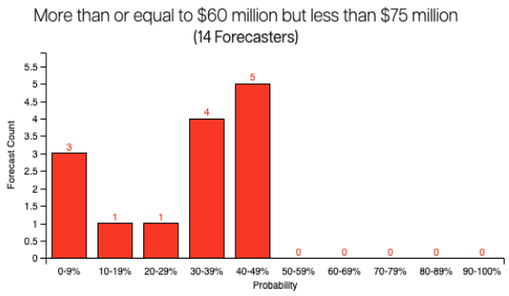


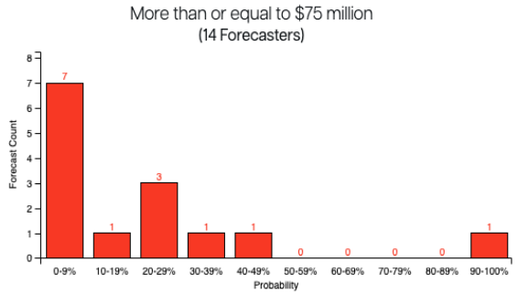
Forecast Distributions (See the most up-to-date distributions here.)











On 31 May 2023, how many total tax incentives will be listed in the Alternative Fuels Data Center?

As both the need and demand for alternative fuels continue to increase, state and federal governments continue to provide tax incentives to encourage alternative fuel use. The Alternative Fuels Data Center (AFDC) tracks these individual incentives through a database that is updated regularly. On September 15th, 2023 there were 105 listed.

Based on 10 forecasts by 9 forecasters:

Possible Answer	INFER % Chance 9/30
Less than or equal to 106	17%
Between 107 and 111, inclusive	22%
Between 112 and 116, inclusive	32%
More than or equal to 117	29%

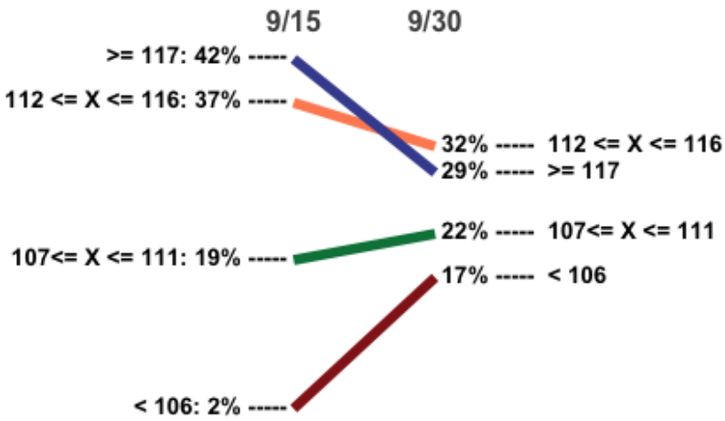
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

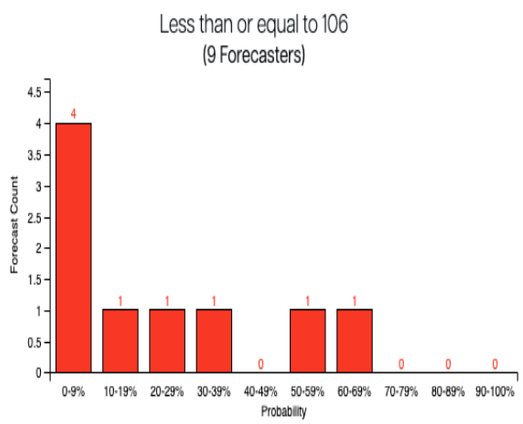
111 or less:	112 or more:
▪ Midterm elections will play a pivotal role. (@estim-nation, 9/30/22) * ▪ It seems there may be inertia here though; and biofuels is doing well enough now even if it had no subsidy. They certainly don't need more subsidies to make a killing. (@Mudiku, 9/26/22) *	▪ The amount of tax incentives has been ~115 during May in previous years, but this year was an exception with 106. I wouldn't draw strong conclusions of the exception, and I'll give a large portion of the probability mass to the two highest bins. (@Sanyer, 9/29/22) * ▪ Based on the historical data, the high point for 2021 was 122. This value then dropped with the end of the year back down to 105. (This drop is seen at the end of most years, though the 2021-2022 transition was sharper than most). I expect throughout 2022 the number to rise back up to (and probably beyond) 122. (@MullenAustin, 9/15/22) *

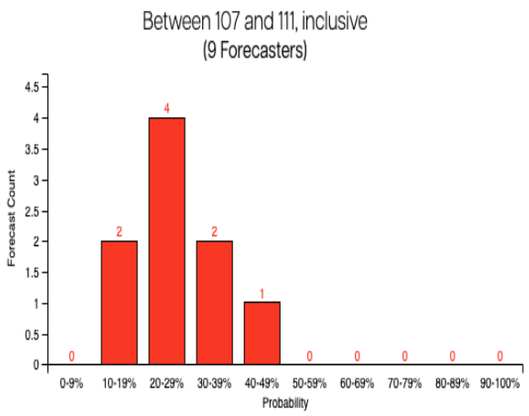
On 31 May 2023, how many total tax incentives will be listed in the Alternative Fuels Data Center?

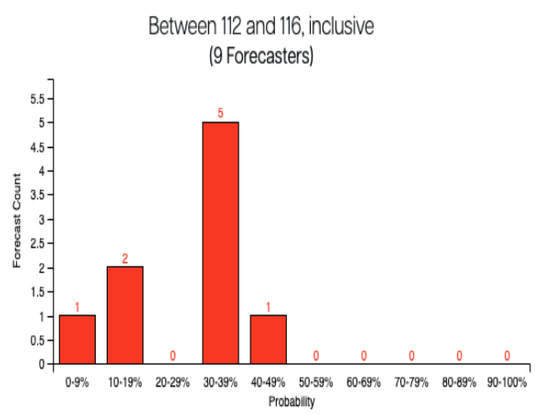
Consensus Trend (See the latest consensus trend here.)

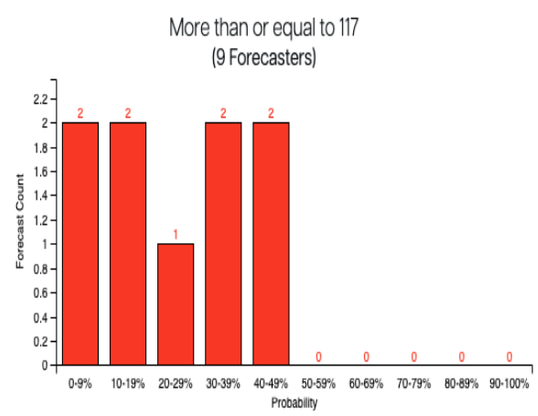


Forecast Distributions (See the most up-to-date distributions here.)









How many "venture capital members" will be part of BioMADE at the end of June 2023?

The Bioindustrial Manufacturing And Design Ecosystem, or BioMADE, is a U.S. Department of Defense Manufacturing Innovation Institute established by the Engineering Biology Research Consortium in April 2021. BioMADE projects encourage the commercialization of biotechnologies, secure the bioindustrial supply chain, and support workforce development as part of its mission to build a sustainable, domestic end-to-end bioindustrial manufacturing ecosystem (Yahoo Finance).

Based on 15 forecasts by 14 forecasters:

Possible Answer	INFER % Chance 9/30
0	1%
1	34%
2	36%
3 or more	29%

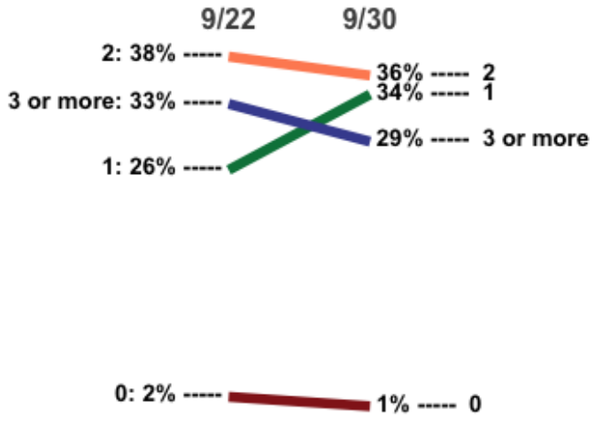
Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

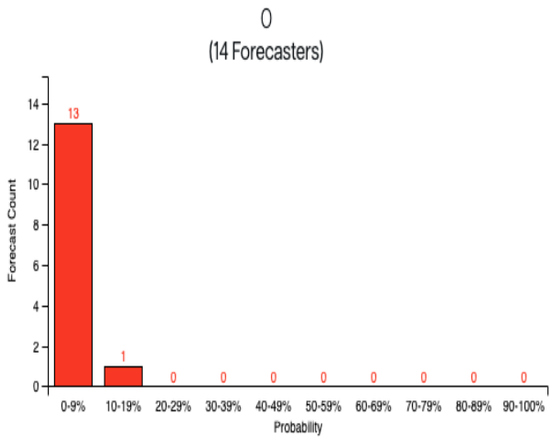
0 or 1:	2 or more:
▪ With only one venture capital member so far, there doesn't seem to be great interest in joining. Most likely this will stay the only member, or add another. (@Jim, 9/30/22) *	▪ There is tons of VC interest in the bio economy. Especially as tech like precision fermentation starts to gain more traction, I believe the industry will explode. VCs want to be part of that. (@Coastbylight, 9/30/22) * ▪ There are currently several venture capital firms that are potential candidates to join BioMade. NfX Bio, ADM Ventures, and SOSV IndieBio are all possibilities, as they have all recently invested in synthetic biology companies. There is potential to secure new technologies and supply chains in synthetic biology due to the level of global geopolitical competition in technology. (@jonathanmaza, 9/22/22) *

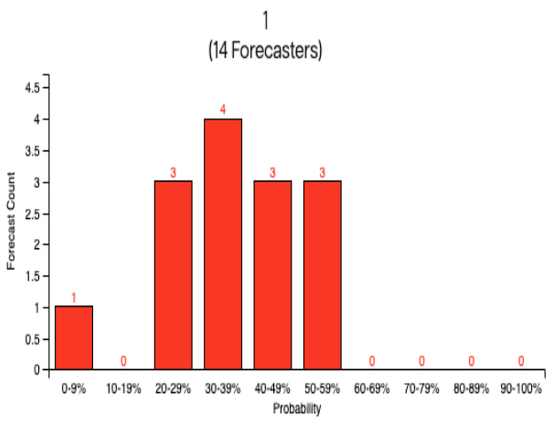
How many “venture capital members” will be part of BioMADE at the end of June 2023?

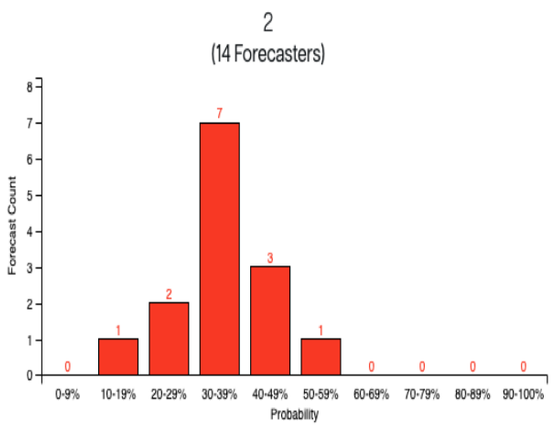
Consensus Trend (See the latest consensus trend here.)

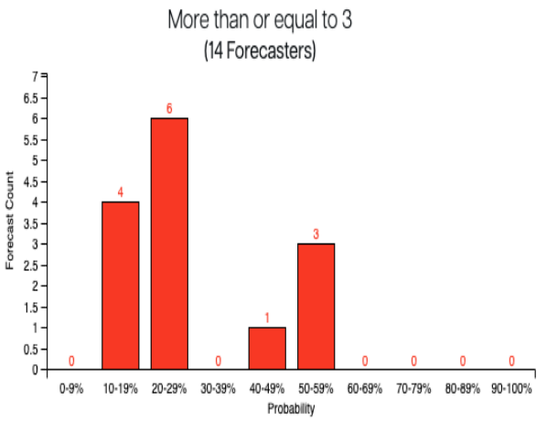


Forecast Distributions (See the most up-to-date distributions here.)









Will United Airlines announce that they are using sustainable aviation fuel produced by Cemvita Factory by 31 Dec 2023?

*This question was published on 29 September 2022. As a result of the short time it has been available to forecast at the time of this report being published, it is not factored into the slider equation on Page 2.

Sustainable aviation fuels (SAFs) are biofuels with similar properties to conventional jet fuel that are used to power aircraft, and recently synthetic biology has been used to create new SAFs. Cemvita Factory uses synthetic biology to convert carbon dioxide into SAF and other chemicals. In March 2022, United Airlines Ventures and Oxy Low Carbon Ventures announced a collaboration with Cemvita Factory to commercialize synthetic biology produced SAF production.

Based on 14 forecasts by 13 forecasters:

Possible Answer	INFER % Chance on 9/30
Yes	61%
No	39%

Summary of Forecaster Rationales (See Live Forecasts and Rationales)

*** = Representative forecast rationales made in the last 30 days**

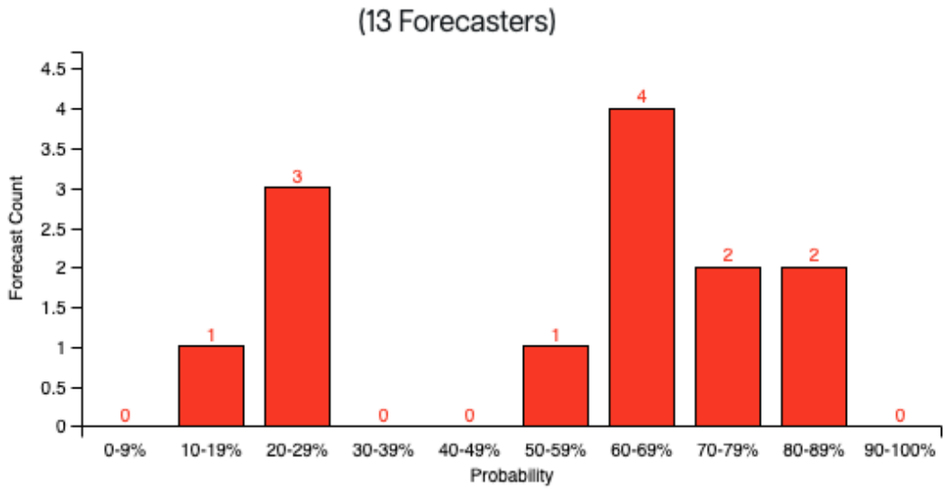
Yes:	No:
▪ There's a good amount of domestic focus on environmental issues right now, and using biofuel for your flights would definitely be good press. (@MullenAustin, 9/30/22) ***** ▪ Since this will resolve with test flights or as a small portion it seems way more likely than if they actually need to use it regularly in flights. The general environment and desire to move away from fossil fuels is also likely to push at least some PR statement on progress. (@Fionack, 9/30/22) *	▪ It sounds like the technology is still in too early a stage for a fuel to be used even in a test flight by the end of 2023. I think the technology would have to be at very advanced stages by now for a fuel to be usable in a test flight by the end of next year, and what I've read suggests to me that they're still trying to get their bacteria to make stuff efficiently. (@Belikewater, 9/30/22) *****

Will United Airlines announce that they are using sustainable aviation fuel produced by Cemvita Factory by 31 Dec 2023?

Consensus Trend (See the latest consensus trend here.)

*Question has not been active long enough to form a consensus trend yet.

Forecast Distributions (See the most up-to-date distributions here.)



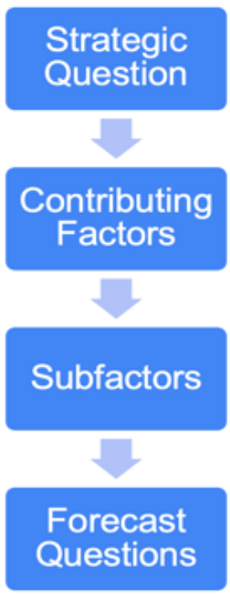
Appendix A - Methodology for Identifying Forecast Questions

INFER operates as a continuous, 4-step life-cycle between U.S. Government policymakers and a global community of forecasters who bring a diverse, informed perspective to their assessment of the future.

1. As initial input, policymakers work with INFER to identify *priority areas* (e.g. "synthetic biology") and *strategic questions* within those priority areas (e.g. "Will synthetic biology fundamentally transform the way the U.S. competes in the oil & gas industry?") where guidance, regulation, or clarification is needed to inform policy and strategy.
2. INFER draws on open source resources and subject matter experts to define what *contributing factors* will need to be understood to best inform the answer to the strategic question (e.g. "What will investment in synthetic biology look like both within the government as well as the private sector?"). We call the process of identifying these pivotal factors "strategic question decomposition."
3. Using those factors identified in the decomposition, we define signals or sign-posts that we can use to assess the outcome of that factor. From those signals, we author *forecast questions* that appear on our public crowdsourced forecasting platform at inferpublic.com (e.g. "When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?").
4. Based on the forecasts the crowd generates, INFER creates curated reports and automated dashboards to share with policymakers. Unlike a one-time survey, individuals are encouraged to update their forecasts over time so INFER can always create near real-time assessments of what will happen in the future.

Here's a model of that strategic question decomposition process and terms we use to describe it:

- **Strategic questions** represent the broad categories we want to learn more about. Breaking down a strategic question is the main focus of a decomposition.
- **Contributing factors** are the primary drivers of the strategic question. They directly influence the outcome in one direction or another.
- **Sub-factors** are the individual elements that make up and influence a contributing factor. Depending on the size and scope of the strategic question, it may be possible to identify signals directly from the contributing factors without the need for sub-factors.
- **Signals** are specific metrics or events that tell us how a factor or sub-factor is trending, and that are ultimately used to create **Forecast questions** we publish on INFER.



Once forecasts have been made, the decomposition model is used to synthesize and analyze data from individual forecasts and glean information about how a strategic question might trend. We call this **recomposition**–the process and product of combining forecasts together to provide insight into the strategic question. This final recomposition can take many forms, e.g., a dashboard, a summary report, or an index.

Decomposing our strategic question about synthetic biology

Forecast questions are selected to provide coverage over the contributing factors and subfactors listed on page 3 , with an emphasis on questions that allow us to assess multiple factors or subfactors at once.

The table below lists the forecast questions INFER has launched to assess our broader strategic question about whether synthetic biology will fundamentally transform the way the U.S. competes in the oil & gas industry.

Contributing Factor	Subfactor	Forecast Question
Costs	Technological	Will the cost of sequencing a human genome drop below $100 before 1 September 2023?
	Input	
Investment	Government	
	Private Industry	How many "venture capital members" will be part of BioMADE at the end of June 2023? When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?
Ecosystem Development	Regulatory Incentives & Disincentives	On 31 May 2023, how many total tax incentives will be listed in the Alternative Fuels Data Center?
	Talent Development	How many U.S. teams will be named as a Winner or Runner Up at the 2022 iGEM Grand Jamboree in Paris?
	Technology Transfers	Will a top U.S. chemical or oil and gas company join the BOTTLE consortium as an industry partner by 31 August 2023?
	Bio-Manufacturing Capacity	What will Ginkgo Bioworks foundry revenue be in the first quarter of 2023?[3]
Demand for Alternative Fuels	Overall Energy Demand	What percentage of the U.S.'s renewable energy consumption will come from biofuels in 2023?
	Fossil Fuel Viability	On 28 February 2023, how many states will be following the California emissions standard banning the sale of new emissions-producing vehicles by 2035?

2 Also touches on bio-manufacturing capacity.

3 Also touches on private investment.

4 Also touches on regulatory incentives and disincentives.

Appendix B - Current Forecaster Pool Profile

Attributes of the INFER forecaster pool:

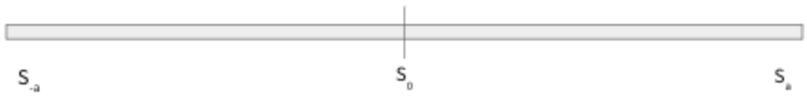
Gender	
Male	58%
Female	29%
Nonbinary, or prefer not to say	13%
Age	
18-24	35%
25-36	32%
37-48	13%
49-60	7%
61+	13%
Country	
United States	55%
Canada, UK, European Union, AUS	23%
South East Asia	8%
Central and South America	13%
Other	1%
Education	
Graduate education (completed or have some)	67%
Undergraduate education (completed or have some)	33%
Degree Fields - choose all that apply	
Science, Engineering, or Technology	34%
Political Science, International Relations, International Business	34%
Foreign Service, Security, or Government	20%
Public Policy	19%
Public Administration, Business Administration	8%
Other	21%
Experience in Relevant Topics **1-Not at all familiar to 5-Very Familiar**	**Rated 4-5**
AI or machine learning	43%
U.S. policy on AI	22%
China policy on AI	16%
Advanced computing (supercomputers, quantum)	18%
Biotechnology	19%
Climate science	27%
Energy	27%
Forecasting and critical judgment	59%
Reasoning, decision making, and rationality	74%
Cognitive psychology	42%

Appendix C - Methodology for Slider Position

For each strategic question, three scenarios are defined:

- S_a: Scenario A
- S_{-a}: Scenario -A represents the opposite of Scenario A
- S_o: Scenario 0 represents perpetuation of the status quo.

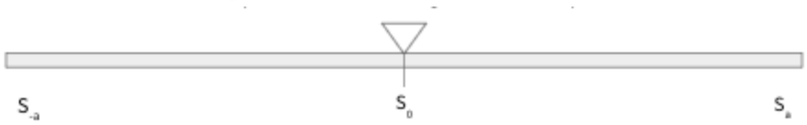
These three scenarios are represented on a horizontal axis, called the slider. This axis runs from -1 to 1, with 0 at the midpoint. The midpoint is labeled S_o, the endpoint at -1 is labeled S_{-a}, and the endpoint at 1 is labeled S_a.



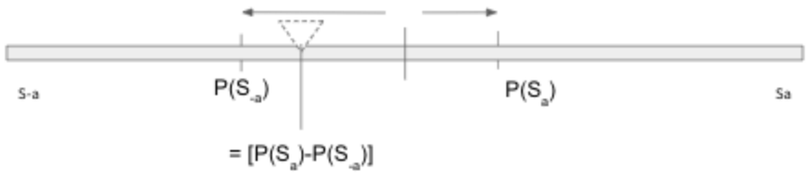
A set of forecasting questions is identified, and their answers are each associated with one of the scenarios S_a, S_{-a}, or S_o. We define the probability of a scenario S_x as the average of the probabilities of the set of outcomes associated with S_x. More formally, for a set of outcomes, O_{xi}, i=1, ...n

$$P(S_x) = \frac{\sum_{i=1}^{n} P(O_{xi})}{n}$$

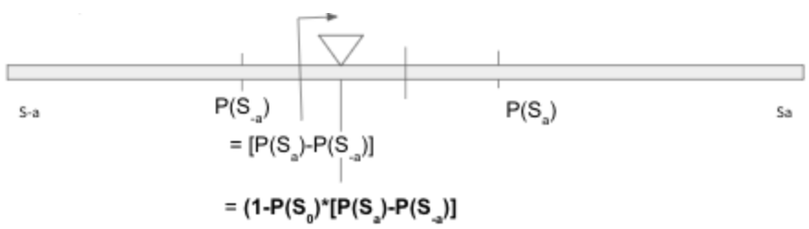
The ticker's position on the slider begins at the status quo, S_o.



The probabilities of S_a and S_{-a} move the ticker toward their respective end points, resulting in a net movement probability of $P(S_a)$-$P(S_{-a})$.



The probability of the status quo scenario, S_o, then moves the ticker back toward the status quo by multiplying the net movement probability by the probability that we depart from the status quo, (1-$P(S_o)$).



The final position of the ticker is thus represented by the following equation:

$$= (1 - P(S_0)) \times [P(S_a) - P(S_{-a})]$$

For the purposes of this report the scenarios are defined as follows:

- S_a: Synthetic biology fundamentally transforms the way the U.S. competes in the oil and gas industry.
- S_{-a}: Synthetic biology has no impact on the way the U.S. competes in the oil and gas industry.
- S_o: Synthetic biology incrementally changes the way the U.S. competes in the oil and gas industry.

The answers of the forecast questions included in this metric are assigned to the following scenarios.

Question	Answers	Associated Scenario
What percentage of the U.S.'s renewable energy consumption will come from biofuels in 2023?	Less than 20%	No Impact
	More than or equal to 20% but less than 24%	Incremental Change
	More than or equal to 24%	Fundamental Transformation
When will ExxonMobil next positively mention algae-based biofuels in its quarterly financial report?	In 3Q 2022 or 4Q 2022	Fundamental Transformation
	In 1Q 2023 or 2Q 2023	Fundamental Transformation
	In 3Q 2023 or 4Q 2023	Fundamental Transformation
	Not before 1Q 2024	No Impact
Will a top U.S. chemical or oil and gas company join the BOTTLE consortium as an industry partner by 31 August 2023?	Yes	Fundamental Transformation
	No	No Impact
How many U.S. teams will be named as a Winner or Runner Up at the 2022 iGEM Grand Jamboree in Paris?	0	No Impact
	1	Incremental Change
	2 or more	Fundamental Transformation
Will the cost of sequencing a human genome drop below $100 before 1 September 2023?	Yes	Fundamental Transformation
	No	No Impact
On 28 February 2023, how many states will be following the California emissions	Less than 5	No Impact
	Between 5 and 11, inclusive	Incremental Change

standard banning the sale of new emissions-producing vehicles by 2035?	Between 12 and 17, inclusive	Fundamental Transformation
	More than or equal to 18	Fundamental Transformation
What will Ginkgo Bioworks foundry revenue be in the first quarter of 2023?	Less than $30 million	No Impact
	More than or equal to $30 million but less than $45 million	Incremental Change
	More than or equal to $45 million but less than $60 million	Incremental Change
	More than or equal to $60 million but less than $75 million	Fundamental Transformation
	More than or equal to $75 million	Fundamental Transformation
On 31 May 2023, how many total tax incentives will be listed in the Alternative Fuels Data Center?	Less than or equal to 106	No Impact
	Between 107 and 111, inclusive	Incremental Change
	Between 112 and 116, inclusive	Fundamental Transformation
	More than or equal to 117	Fundamental Transformation
How many "venture capital members" will be part of BioMADE at the end of June 2023?	0	No Impact
	1	No Impact
	2	Incremental Change
	3 or more	Fundamental Transformation