

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 8-K

CURRENT REPORT

PURSUANT TO SECTION 13 OR 15(D) OF THE
SECURITIES EXCHANGE ACT OF 1934

Date of Report (Date of earliest event reported): August 9, 2023

LanzaTech Global, Inc.

(Exact name of registrant as specified in its charter)

Delaware

(State or other jurisdiction
of incorporation)

001-40282

(Commission File Number)

92-2018969

(I.R.S. Employer
Identification No.)

8045 Lamon Avenue, Suite 400
Skokie, Illinois

(Address of principal executive offices)

60077

(Zip Code)

(847) 324-2400

(Registrant's telephone number, including area code)

Not Applicable

(Former name or former address, if changed since last report)

Check the appropriate box below if the Form 8-K is intended to simultaneously satisfy the filing obligation of the registrant under any of the following provisions:

- Written communication pursuant to Rule 425 under the Securities Act (17 CFR 230.425)
- Soliciting material pursuant to Rule 14a-12 under the Exchange Act (17 CFR 240.14a-12)
- Pre-commencement communications pursuant to Rule 14d-2(b) under the Exchange Act (17 CFR 240.14d-2(b))
- Pre-commencements communications pursuant to Rule 13e-4(c) under the Exchange Act (17 CFR 240.13e-4(c))

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading Symbols	Name of each exchange on which registered
Common Stock, par value \$0.0001 per share	LNZA	The Nasdaq Stock Market LLC
Redeemable Warrants, each whole warrant exercisable for one share of Common Stock at an exercise price of \$11.50	LNZAW	The Nasdaq Stock Market LLC

- Indicate by check mark whether the registrant is an emerging growth company as defined in Rule 405 of the Securities Act of 1933 (§230.405 of this chapter) or Rule 12b-2 of the Securities Exchange Act of 1934 (§240.12b-2 of this chapter).
- If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Item 2.02. Results of Operations and Financial Condition.

On August 9, 2023, LanzaTech Global, Inc. (Nasdaq: LNZA), held a conference call announcing its financial results for the first fiscal quarter ended June 30, 2023. A full transcript of the conference call (the "Transcript") is furnished as Exhibit 99.1 to this Current Report on Form 8-K. A recording of the webcast and the Transcript have also been posted on the Company's website at ir.lanzatech.com.

The Transcript contains certain non-GAAP financial measures. A reconciliation of GAAP results and non-GAAP financial measures is available in the Company's earnings release dated August 9, 2023, which is posted on the Company's website and was included as Exhibit 99.1 to the Company's Current Report on Form 8-K filed with the Securities and Exchange Commission on August 9, 2023.

The information in Item 2.02 of this Current Report on Form 8-K, including Exhibit 99.1 furnished herewith, is being furnished and shall not be deemed "filed" for any purpose of Section 18 of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), or otherwise subject to the liabilities of such Section. The information in this Current Report on Form 8-K shall not be deemed to be incorporated by reference into any filing under the Securities Act of 1933, as amended, or the Exchange Act, except as shall be expressly set forth by specific reference in such filing.

This Form 8-K and the transcript furnished herewith may include statements that are "forward-looking statements" within the meaning of the safe harbor provisions of the U.S. Private Securities Litigation Reform Act of 1995. All statements herein or in the exhibit hereto other than statements of historical fact are "forward-looking statements," which involve risks and uncertainties and are only predictions. Actual events or results may differ materially from those contemplated by forward-looking statements for a variety of reasons, including those described in the transcript furnished herewith. There are risks that the Company faces that could cause actual results to be materially different from those that may be set forth in forward-looking statements made by the Company. There also may be additional risks that the Company does not presently know or that it currently believes are immaterial which could also impair its business and results of operations. You are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates. The Company undertakes no obligation to publicly update or revise any forward-looking statements, whether as a result of new information, future events or otherwise. Additional information regarding factors that could materially affect results and the accuracy of the forward-looking statements contained herein, or the transcript furnished herewith, may be found in the transcript and in the Company's quarterly report on Form 10-Q filed with the SEC on August 9, 2023, and any subsequent filings with the SEC.

Item 9.01. Financial Statements and Exhibits.**(d) Exhibits**

Exhibit Number	Description
99.1	Transcript of August 9, 2023 conference call
104	Cover Page Interactive Data File (embedded within the Inline XBRL document).

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned hereunto duly authorized.

Dated: August 9, 2023

LANZATECH GLOBAL, INC.

By: /s/ Joseph Blasko
Name: Joseph Blasko
Title: General Counsel and Corporate Secretary



LanzaTech Global Inc.

Second Quarter 2023 Earnings Conference Call

August 9, 2023

CORPORATE PARTICIPANTS

Omar El-Sharkawy, *Vice President, Corporate Development*

Jennifer Holmgren, PhD, *Chairman and Chief Executive Officer*

Geoff Trukenbrod, *Chief Financial Officer*

CONFERENCE CALL PARTICIPANTS

Leo Mariani, *ROTH MKM*

Thomas Meric, *Janney Montgomery Scott, LLC*

Pavel Molchanov, *Raymond James*

Tom Curran, *Seaport Research Partners*

John Annis, *Stifel*

PRESENTATION

Operator

Greetings, and welcome to the LanzaTech Global Inc. Second Quarter 2023 Earnings Conference Call.

All participants will be in listen-only mode. Should you need assistance, please signal a conference specialist by pressing the star key, followed by zero. After today's presentation, there will be an opportunity to ask questions. (Operator instructions).

Please note, this event is being recorded.

I now hand the conference over to Omar El-Sharkawy, Vice President of Corporate Development. Please go ahead.

Omar El-Sharkawy

Good morning and thank you for joining us for LanzaTech Global Inc.'s Second Quarter 2023 Earnings Conference Call.

On the call today, I'm joined by our Chairman and CEO, Dr. Jennifer Holmgren, and our CFO, Geoff Trukenbrod.

Earlier this morning, we filed with the SEC our quarterly report on Form 10-Q for the quarter ending June 30, 2023, and issued a press release with our second quarter 2023 financial and operating results, as well as an Investor Presentation summarizing the Company's performance and key operational highlights for the quarter. Both our press release and results summary Investor Presentation can be found in the Investors section of our website at www.lanzatech.com.

Before we begin, I'd like to direct you to the disclaimers in the front of the Company's Investor Presentation and remind you that today's call may include forward-looking statements. Any statements describing our beliefs, goals, plans, strategies, expectations, projections, forecasts, and assumptions are forward-looking statements. Please note that the Company's actual results may differ from those anticipated by such forward-looking statements for a variety of reasons, many of which are beyond our control. Please see our recent filings with the Securities and Exchange Commission, which identify the principal risks and uncertainties that could affect our business, prospects, and future results. We assume no obligation to update publicly any forward-looking statements.

In addition, we will be discussing and providing certain non-GAAP financial measures today, including Adjusted EBITDA. Please see our earnings release and filings for a reconciliation of these non-GAAP measures to their most directly comparable GAAP measure.

Today's call will begin with remarks from Jennifer providing an overview of and update on our 2023 execution priorities, including our recent financial results. Geoff will then review in greater detail our financial results from the second quarter and provide additional insight into our business model and growth of the business. At the conclusion of these prepared remarks, we will open the line for questions.

With that, I'll turn the call over to Jennifer.

Jennifer Holmgren

Thank you, Omar, and thanks to everyone for joining us today.

As we continue our mission to recycle the world's waste carbon supply, the urgency of acting on climate change and creating a circular carbon economy is becoming increasingly evident.

In the second quarter alone, the effects of climate change—exacerbated by the early return of El Niño—have impacted countless lives and caused vast commercial disruption globally. According to the U.S. National Oceanic and Atmospheric Administration, NOAA, the cost of climate and weather disasters in the United States alone last year totaled more than \$165 billion. This data demonstrates how important it is to advance sustainable business models that align commercial, social, and environmental strategies. Our work is centered around reorienting how the world uses waste carbon in a way that creates value. LanzaTech's performance this quarter demonstrates that we're continuing to make progress.

Within this fiscal year, the annual installed production capacity enabled by LanzaTech's technology will capture roughly twice the amount of carbon as it did last year. We are doing this not by the old paradigm of scaling up, but by numbering up, which means local execution on a global scale. This approach translates into the utilization of locally sourced raw materials so that every country can secure and benefit from its own domestic supply chain.

Turning now to our results, and with the first half of the year completed, I'd like to share our second quarter results within the framework of our 2023 execution priorities as outlined on Slide 5 of the presentation.

First and foremost, safety. In the second quarter, we had zero lost time injuries and zero recordable injuries across our global operations from our offices and laboratories to our commercial scale plants.

Second, global production. We are on target to grow our cumulative installed nameplate capacity by over 100% over 2022 capacity, to more than 300,000 tons per year or approximately 100 million gallons per year by the end of 2023. You can see this on Slide 7. Importantly, this capacity growth includes expansion of our geographic footprint to include India and the European Union.

In India, alongside our partner IndianOil, we continue to make progress towards full production of our 33,500 ton per year commercial facility that will convert carbon dioxide-rich refinery off-gas into ethanol. This is the first commercial deployment of our technology in a refinery using refinery off-gases.

In Europe, with our partner ArcelorMittal, initial samples of ethanol were produced at the 64,000 ton per year facility in late May. Commercial-scale ethanol production from the bioreactors is expected to follow in the fourth quarter.

In China, a 60,000 ton per year facility at a ferroalloy mill successfully started up in the second quarter. This project marks our fourth facility with our joint venture partner Shougang, and it is currently ramping up to full-scale commercial production.

Once these three additional commercial plants are fully operational, the cumulative installed nameplate capacity of our existing and new commercial scale facilities will equate to removing over 500,000 tons of carbon dioxide from the atmosphere every year. This is what gives me the confidence that LanzaTech will be a gigaton scale solution for carbon abatement, something that the planet urgently needs.

Turning to sustainable aviation fuel, or SAF, LanzaJet continues to make progress towards the 2023 completion of the world's first ethanol-based alcohol-to-jet SAF plant at the LanzaJet Freedom Pines Fuels facility in Georgia, as you can see on Slide 8. Once operational in 2024, this plant will produce 10 million gallons per year.

In addition to the development at Freedom Pines Fuels, LanzaJet has made tremendous progress and continues to be extremely well positioned in the SAF market. Earlier this year, LanzaJet entered a Memorandum of Understanding with IndianOil, to explore the development of SAF production in India, and in March they announced a collaboration with Jet Zero Australia for the first alcohol-to-jet production plant in Australia. Most recently, LanzaJet entered an MoU with Airbus, to advance the building of SAF facilities which will use the LanzaJet AtJ process. This agreement also represents a collaboration to accelerate the certification and adoption of 100% drop-in SAF which would eliminate the use of fossil fuels without necessitating any changes to existing aircraft or infrastructure. In addition, this would eliminate the need for aromatics in aviation fuel which will bring in additional benefits, including reduction of contrails and particulate emissions as shown by our 2021 study with NRC Canada.

We are proud of the work LanzaJet is doing and, as a meaningful shareholder of the business, are excited about the position they're building as a leader in the SAF market.

Together with LanzaJet, we are also making strong progress in advancing several other SAF projects that will utilize waste-based ethanol feedstock produced through the LanzaTech platform. These projects include our SAF project in the United Kingdom, which received a \$30 million grant from the UK Department for Transport late last year. For this project, LanzaTech selected Technip Energies as a technology provider and awarded Fluor Corporation the contract to provide front end engineering and design for the project. In addition, Air New Zealand and the New Zealand Ministry for Business, Innovation, and Employment awarded LanzaJet, LanzaTech and Z Energy—a wholly owned subsidiary of Ampol Group and New Zealand's largest fuel retailer—a feasibility study to convert local New Zealand waste products into ethanol and then utilize that ethanol to produce SAF. SAF is a critical part of the global energy transition, and we

are proud to be helping the aviation industry reduce its carbon footprint without impacting land, water, or food resources.

Let's turn now to our third execution priority, commercial growth.

The demand driving our capacity increases is also resulting in robust revenue growth for our business. We saw year-on-year revenue growth of 31% to \$12.9 million for the second quarter. This revenue performance for the first half of the year was in line with our projections and is consistent with our previously provided revenue guidance of \$80 to \$120 million in 2023. However, with more than half of calendar 2023 behind us, we are tightening our 2023 revenue guidance to \$80 to \$100 million. The updated and narrowed range reflects greater visibility into the expected timing of projects we're currently executing, and it continues to reflect the back-end weighting associated with our 2023 forecast. The revenue associated with the higher end of our original revenue guidance range now moves into 2024, further bolstering our 2024 growth outlook.

Our commercial pipeline continues to grow as outlined on Slide 10, setting the stage for a very strong 2024 and beyond. We continue to add projects to the pipeline funnel and are seeing steady progression of individual projects through the pipeline, moving through various stages of engineering. In fact, we saw two projects progress to the advanced engineering stage during the second quarter and anticipate several additional projects will move into advanced engineering through the second half of the year.

Let's now look at our short-, medium-, and longer-term revenue growth pictures.

We are creating a new industry as we work toward our vision of a circular carbon economy, and each business line—Biorefining, Joint Development & Contract Research, and CarbonSmart—contributes to that goal. We are assembling a global ecosystem of participants from deployment partners such as Primetals Technologies and Technip Energies and key supply chain players including Plastipak and BASF, to product developers like On, Zara, COTY, Addidas and H&M Move, which resulted in product lines in stores this year, including a new Gucci fragrance that contains 100% carbon-captured ethanol. This ecosystem also includes waste processors such as Tadweer in the Middle East and NextChem, in Italy. We are making progress with both partners with the engineering now complete on our project with NextChem in Rome. With these partners, we plug into existing value chains to have immediate impact while we build a new circular material system. We acknowledge that bridging different industries means we don't fit squarely into a single category, so I hope that as we next go through our business lines, we can effectively break down how these different workstreams are contributing to our revenue growth.

Starting with our Biorefining business line, we expect engineering services and sales of equipment packages on several key committed and contracted projects to drive revenue most significantly in the second half of 2023. On the engineering services side, we expect continued significant contributions from our integrated gas fermentation and alcohol-to-jet SAF project in Wales, which we call Project Dragon, as well as from our projects with Bridgestone, Woodside, and several others. Initial equipment package sales are expected to commence in the third and fourth quarters this year, including on projects with Woodside in Australia, GAIL in India, as well as on two other projects in India.

For our CarbonSmart business line, we expect 2023 revenues to be multiples of our 2022 performance, fueled by planned commercial campaigns from brand partners across many consumer product verticals in the second half of 2023.

In our Joint Development & Contract Research business line, we continue to see revenues committed or under contract contributing to the top line in the second half of the year, showing customer demand for solutions that lower the carbon footprints of their supply chains. As recent evidence of this customer demand, we recently signed a joint collaboration agreement with Technip Energies to create a new pathway

to sustainable ethylene utilizing our combined technologies. Just like with Primetals Technologies, we expect Technip to also serve as a channel to market helping us better access the petrochemical sector.

Longer term, our project pipeline is laying the foundation for strong revenue progression. Over the next several quarters, we will continue to be in the deployment stage as we advance projects through the pipeline. While Geoff will provide additional insight into the workings of our pipeline in a few moments, I would like to highlight that the bulk of the near-term Biorefining revenue will come from the sales of engineering services and equipment packages as projects move from early-stage engineering to advanced engineering, and then from advanced engineering into construction. This is our numbering up strategy in action.

Moving to our fourth execution priority Adjusted EBITDA, given the strong momentum we are seeing across our business, we are reiterating our forecast to achieve positive Adjusted EBITDA by the end of 2024 as our commercial pipeline continues to expand.

Turning back now to recent performance, Adjusted EBITDA for the second quarter totaled negative \$23.8 million, bringing the Adjusted EBITDA loss for the first half of 2023 to negative \$47.3 million.

There are several cost factors that have contributed to the Adjusted EBITDA loss during the first half of the year. First is talent. We expedited the expansion of key teams to support strategic growth throughout 2023 and into 2024, including in our engineering and strategic project groups. The development and expansion of these teams will accelerate project development across the board, but especially within our pipeline of projects to be co-developed with Brookfield, several of which will enter early-stage engineering in the coming months. We look forward to making our first announcements on these projects very soon.

In addition, we pride ourselves on attracting and retaining top talent across the organization. Like other companies, we are facing an increasingly competitive job market. This macro dynamic, combined with our continued investment in people and our focus on retention has led to upward pressure on our overall compensation expense.

Finally, we saw increased costs associated with moving ahead of schedule for demonstrations of our isopropanol-producing microbe at scale. Isopropanol is a chemical intermediate that can be used in multiple supply chains. For example, isopropanol can be used to make polypropylene, which had a 2022 market size of around \$120 billion, and has applications in numerous industries, including medical, automotive, packaging, building, and construction. This is a big deal as the flexibility of additional commercial microbes will allow our partners to potentially use the same LanzaTech biorefining hardware to switch between products, taking advantage of market fluctuations and demand cycles. We anticipate sharing more progress on this in the second half of the year.

Given the updates to our forecasted full-year 2023 revenue guidance, as well as the factors I have just mentioned, we are updating our 2023 Adjusted EBITDA guidance to a range of negative \$75 million to negative \$65 million versus negative \$65 million to negative \$55 million previously.

Once again, we remain confident that our growth initiatives along with continued investment in our people and resources will support project deployments and growth over the medium term, supporting our continued expectation to turn Adjusted EBITDA positive by the end of 2024.

Moving on to our fifth execution priority, process competitiveness. Since the third quarter last year, our second-generation bioreactor has been in operation at a demonstration-scale facility in Alberta, Canada, with our partner Suncor. This improved design does several important things. First, it improves production yields by up to 15% to 20% which means greater revenues for our partners and for LanzaTech through ethanol sales and royalty revenue. Second, the design optimization reduces the costs for our partners,

improving the return on investment. And lastly, as mentioned previously, we are ahead of schedule on the demonstration of our isopropanol production microbe in the second half of this year.

With that, I'll turn the call over to Geoff to provide details on our financial performance and share further insights into how to think about forecasting the growth of our business. Geoff, please go ahead.

Geoff Trukenbrod

Thank you, Jennifer, and good morning. Thank you to everyone joining us.

I will first start with a recap on our second quarter results and then provide some incremental color on our business model and how to think about forecasting our growth.

As seen on Slide 12 of the presentation, second quarter revenue from our Biorefining carbon capture and utilization category grew 64% year-on-year, reaching \$9.7 million, driven mainly by ongoing and recently initiated engineering services work on several projects. Research and development revenue, which includes our Joint Development and Contract Research work, reached \$2.2 million in the quarter and CarbonSmart revenue totaled \$1 million. Total revenue for the first half 2023 of \$22.6 million was in line with our forecast. As we have previously suggested, we have consistently anticipated a significant back-end weighting to revenue generation this year and are targeting more than 70% quarter-on-quarter growth on average during the second half of the year, as more projects progress through the Biorefining pipeline and additional CarbonSmart campaigns are fulfilled.

Cost of sales in the second quarter increased 46% over the same period last year, reflecting 31% higher revenue year-over-year for the quarter and the significant costs of engineering and other services on our integrated waste-based ethanol to SAF project in the UK, which we call Project Dragon. The lower year-to-date gross margins, and the quarter-on-quarter decline in gross margin is largely attributable to this project, one of our biggest sources of revenue this year. The revenue contribution from Dragon, in the form of engineering services, will continue to be realized over the course of this year and into next, however, given our 20% cost-share obligation associated with this government contract, we record negative gross margin on the project. Still, this is a great opportunity for us, as we have a contracted and committed revenue source to develop this flagship integrated facility, which combines gas fermentation and alcohol-to-jet technologies, while continuing to own the development rights to the project. We do anticipate gross margin improvement in the second half of the year as we expect several projects to commence engineering services, adding higher-margin revenues to the sales mix in the coming quarters.

With regards to the year-over-year increase in operating expenses, the SG&A component of operating expense expanded mainly as a result of growth in our overall headcount, going from approximately 340 people to over 400 people in the last 12 months, expedited expansion of key teams critical to our strategic growth objectives, increased compensation to prioritize talent retention, as well as higher professional services expenses and certain ongoing public company costs. The investments in our engineering and strategic projects teams reflect, in part, an exciting pace of progress in project development within our Brookfield partnership.

The research and development component of operating expenses increased \$5.7 million year-over-year in the second quarter, consistent with our forecasted costs and reflecting our ongoing investment in people, innovation and process improvement in our gas fermentation platform and microbe commercialization activities beyond ethanol-producing microbes. The latter efforts, one of our 2023 execution priorities, are progressing well and those commercialization efforts have increased our costs in 2023, as we bring more of that work into 2023 as compared to 2024.

We expect operating expenses in the second half of 2023 to be less than the level in the first half as we experienced several one-time expenses in the first half, mainly from professional services associated with the closing of the business combination, accelerated vesting of restricted stock awards, and various compensation-related expenses associated with transitioning employees.

Net loss in the quarter was negative \$26.8 million and Adjusted EBITDA was negative \$23.8 million. Turning to Adjusted EBITDA loss for the first half of 2023, of negative \$47.3 million, we recast the Adjusted EBITDA loss in the first quarter from negative \$27.6 million to negative \$23.5 million. We previously did not exclude from Adjusted EBITDA certain one-time costs related to the business combination and initial securities registration that occurred during the first quarter. We believe that excluding these one-time costs, mostly related to professional services, provides a more accurate picture of the Company's operating performance.

With today's updates to our full-year 2023 revenue and Adjusted EBITDA guidance, we want to reiterate the importance of viewing our business over a long horizon due to the significant impacts that can result from minor timing shifts in our large-scale projects. Said another way, today's guidance updates mainly reflect our updated view of project timing, not a net change in our growth opportunities nor our path to positive Adjusted EBITDA between now and the end of 2024.

Taking into consideration these one-time expenses in the first half of the year, and the investments in 2023 to accelerate multiple aspects of our planned business strategy, the medium-term outlook for the business shows a faster execution of our planned strategy, gross profit growth, and lower normalized future expense run rates. In short, we are extremely pleased with where we are headed and believe our business plan is stronger than ever.

Turning to the balance sheet, we exited the quarter with cash, cash equivalents, restricted cash, and investments in U.S. Treasuries totaling approximately \$161.1 million. Cash burn in the quarter was approximately \$33.8 million, of which \$5.5 million was one-time in nature associated with our participation in the LanzaJet shareholder loan alongside our other LanzaJet shareholders. We expect cash burn to reduce in the second half of the year and with our current liquidity combined with our confidence in achieving positive Adjusted EBITDA in late 2024, we continue to believe that we are well capitalized with adequate financial flexibility to achieve our growth objectives.

I'd now like to turn to a discussion on how to think about forecasting our growth.

Over the last several months we've engaged extensively with the investment community, many of whom expressed interest in more clearly understanding how individual projects advance through the development pipeline and contribute to our financial results. With this feedback in mind, we've laid out some of the key financial drivers and forecasting principles on Slide 14 of the presentation.

For our Biorefining business line, where we license our core technology platform to customers, I'd like to provide some incremental color on how we think about the financial contribution of a typical plant through its development cycle. We think about the project lifecycle in two distinct buckets, with a series of stage gates, which you can see presented on Slide 15: first, the development stage, and second, the operating stage. We generate revenues through our services and licensing model in each these stages and we want to unpack that a little further here. First, the development stage is broken up into three main categories: A) early-stage engineering; B) advanced engineering; and C) construction. During this stage we realize revenues associated with our engineering and startup services, as well as revenues from the sale of equipment. While we do not typically provide all of the equipment for a project, we provide key components of the equipment package, especially those that are based on our proprietary designs.

During the second stage, the operating stage, we begin to realize a variety of high-margin recurring revenues, including a running royalty, typically tied to the gross revenue of the plant's output; the ongoing

sale of microbes and media—effectively consumables in the process—as well as software, monitoring and analytics services designed to help our licensees optimize the operations of their facilities.

I will now turn to how projects progress through our pipeline and over what periods of time.

Prior to entering our forecast pipeline, each opportunity completes a preliminary technoeconomic analysis or TEA, which, upon yielding positive economic results, will likely advance the opportunity along to the first stage, early-stage engineering. We see approximately 50% to 60% of projects with positive TEA results advance to early-stage engineering and believe that is an appropriate probability factor to apply to our pipeline of projects at that stage.

In early engineering, a customer engages in a paid feasibility study, generating additional engineering detail and scoping. A recent example of a project entering this phase in the commercial pipeline is with our integrated SAF project with Air New Zealand. We forecast that approximately 70% to 80% of projects completing a feasibility study will ultimately move forward to the advanced engineering stage. It is in these engineering stages where LanzaTech begins to receive a substantial engineering services revenue, typically between \$1 and \$5 million, the bulk of which is realized in the advanced engineering stage through a basic engineering package or BEP. The contracting of a BEP marks an important milestone of a project's development and is a significant predictor of the progression of our long-term financial performance. Examples of projects in our current commercial pipeline at this stage include our project in Rome with partner NextChem, as well as our recently added project with partner Bridgestone. Approximately 80% to 90% of projects that have completed a BEP have earned a positive financial investment commitment by the customer and will enter the next portion of the development stage: the construction phase.

Once in construction, we generally expect a near 100% probability that a project will complete construction and start up. During this construction stage, LanzaTech realizes revenues through two streams; first, the sales of key proprietary componentry and equipment packages, typically in the range of \$15 million to \$20 million depending on several factors, including but not limited to capacity, integrations, and geography, and second, startup services and operational training, typically in the range of \$1 million to \$3 million.

From TEA to construction completion, we anticipate the timeline to be approximately 24 to 36 months; approximately 12 months in the pre-construction phases and 12 to 24 months in the construction phase. Once construction is completed, the project enters start up and full-scale operations.

It is in the operating stage that the project generates recurring revenues for LanzaTech through the licensing royalties, the ongoing sales of microbes and media, and the ongoing sales of software, monitoring and analytics services. Our licensing royalty is typically structured as a percent of gross revenue on the sales of product from the facility, with royalty rates typically in the high single-digit percentages.

We believe that the anchor KPI for estimating the long-term buildup of revenues in the Biorefining business line should be the number of BEP starts each year. Once a project has commenced a BEP, the significant engineering services revenues begin to contribute to our results and, once completed, there is a high probability of the project advancing through to construction and then on to operations.

Given the timelines involved in our project deployment, we believe it helps to think about our business on an annual basis rather than quarterly. These Biorefining projects are large capital investments, on the order of several hundred million dollars depending on the size, integration, and location. These investments are made by our licensing customers, and the projects are developed and constructed over multiple years; therefore, it is not uncommon to face delays associated with project decision-making by customers. This dynamic can result in a shift of project milestones, which can contribute to some challenges in forecasting quarterly results with precision.

Slide 16 outlines the number of projects we target commencing a BEP in 2024 and 2025 on a probability adjusted basis, based on our current project pipeline.

The illustrative economics to LanzaTech of a 50,000 ton per annum facility from each of the development and operating stages are also shown on Slide 16. As you would expect, based on the pipeline progression demonstrated, our near-term revenues will be dominated by one-time revenues earned during the development stage, while we are building up a base of licensed operating assets with long tail recurring revenue streams at extremely attractive margins to LanzaTech.

Jennifer discussed earlier our three new partner facilities opening this year, so I also wanted to expand a bit on the revenue dynamics of these projects. It is important to remember that many of these are first-of-a-kind plants; for example, the first LanzaTech biorefinery in Europe, and simultaneously the first plant in India which is the first LanzaTech facility utilizing refinery off-gas.

Our third new project is our fourth plant in China, and it is held through a joint venture structure with our partner Shougang. Therefore, the recurring revenues associated with the licensing royalties from these plants look different and are not indicative of the plants in the current commercial pipeline.

As mentioned back on Slide 14, we expect Joint Development and Contract Research to grow modestly year-on-year and be a smaller component of overall revenue in the medium term. This work will continue to help prioritize our roadmap for new microbes and drive process optimizations.

We expect CarbonSmart revenue to significantly grow year-on-year over the medium term as more plants come online and LanzaTech secures offtake supply from these plants to place into our customers and partners CarbonSmart supply chains.

I will now turn the call back over to Jennifer for some closing remarks before we open the call for Q&A. Jennifer?

Jennifer Holmgren

Thank you, Geoff.

In summary, we had another strong quarter with continued growth across our business. Our first half 2023 revenues grew 27% year-on-year compared to the first half 2022. Our focus is squarely on business execution and delivering the results we guided the market to for the rest of the year. We continue to deliver solutions that can help us make a paradigm shift in treating carbon as an opportunity rather than as a liability. Customers ranging from heavy industry to personal care companies and airlines are becoming carbon champions as they see the value in turning carbon from a cost to a profit center, while creating a more sustainable future for all.

I am proud to represent a team and partners across multiple sectors who share our vision of a circular carbon economy and I look forward to continuing to deliver positive results, as evidenced by LanzaTech's recently being named one of the TIME100 Most Influential Companies, alongside other audacious companies changing the world.

Thank you for joining us and to so many of you for your support.

Operator, we can now open the lines for Q&A, please.

Operator

Thank you. (Operator instructions).

The first question comes from Leo Mariani from ROTH MKM. Please go ahead.

Leo Mariani

Hi guys. I was hoping we could get a little bit more detail on the revenue growth expected in the second half of the year. It looks like you guys need to do around \$67 million to kind of hit the midpoint of the revised guidance. Just trying to get a sense of what are the major projects that contribute. You mentioned Dragon on the call. Presumably you're going to see also just ramping revenues from the IndianOil plant here as well as the ArcelorMittal plant in Belgium. But maybe can you talk about some of the other key plants that sort of drive that ramp here in the second half?

Jennifer Holmgren

Thank you for your question, Leo. I'm going to pass this one over to Geoff to address.

Geoff, can you please provide more detail?

Geoff Trukenbrod

Sure. Hey Leo, good to hear from you.

In terms of just revenue growth here for the year for the back half, I mentioned a little bit in our prepared remarks some of the plants that are coming online. But largely it's a function of the plants that are in the development stage that are—the projects that are in the development stage that are coming along. We mentioned a couple of them that we've announced already: increasing work with partners Woodside, Bridgestone, NextChem, GAIL, etc. We expect to see expansion of our engineering services and equipment revenues in the back half of the year which will also be kind of positive gross margin improvements over some of the work we did in the first half, as we mentioned – Project Dragon and others.

Leo Mariani

Okay. Then with respect to 2024, you guys have previously spoken about greater than 2x revenue growth next year on a year-over-year basis. Do you guys still feel confident that that's kind of the right number to be thinking about in light of the fact that you reduced the '23 guidance a little bit here on revenues.

Geoff Trukenbrod

Yes, we do. In fact, we think the revenue that has kind of slipped out of 2023 into 2024 sets us up nicely for that type of revenue growth. We do continue to believe that it's going to take that type of revenue to get to that EBITDA breakeven, EBITDA positive number by the end of next year, but we are continuing to reaffirm that.

Leo Mariani

Okay. Then you spoke briefly about gross margins. Wanted to see if we could get a little bit more color in terms of the progression in 3Q and 4Q of '23. I mean, your gross margins have fallen, it looks like the last three quarters. It was 26% in the third quarter of '22, 16% in the second quarter here of '23, so how should we be expecting that progression unfold here in the second half? Can you help us out with maybe some numbers here on this?

Geoff Trukenbrod

Yes, absolutely. We expect it to revert to some of the gross margins that we had seen previously. This quarter and first quarter this year were dragged down pretty significantly in terms of a gross margin standpoint just based on the revenue mix. The revenue mix being heavily weighted to Project Dragon and some of our Contract Research work in the first half. The Project Dragon being kind of the most significant component of our revenue mix in the first half runs at a negative gross margin; it's work that we're doing with funding that's provided from the UK Government. There's a cost share component of that and the cost share component, part of that actually, results in effectively a negative gross margin. So all of that work is actually bringing our gross margins down. Again, it's a great project and we're really excited about doing it; we think it sets us up for important milestones in late '23 and 2024. We continue to own the development rights of that project and so, again, we're very excited about it, but it is a drain on gross margin in 2023. That will be diluted by these additional revenues sources that are coming online in the back half of the year and that's why we'll see some reversion to some of our kind of historic gross margin levels.

Leo Mariani

Okay. Then just on R&D expense, it looks like that's gone up a fair bit in the last couple of quarters. I think you guys were running kind of \$13 million to \$14 million per quarter in the back half of '22. It was \$16 million in the first quarter and now it's \$19 million this quarter. You guys did talk about some kind of one-time start-up costs. I wasn't sure if some of those were going into the R&D expense number. It wasn't crystal clear to me, so I'm just trying to get a sense, do you expect that R&D falls from this \$19 million quarterly run rate in the second half of the year? Is that going to go down here?

Geoff Trukenbrod

We think it's going to be fairly consistent. Largely the biggest component of our OpEx is people and the biggest amount of our people has historically been—although it is declining as a percentage—are R&D staff. The R&D staff did increase year-over-year, so that's largely what's driving that, as well as some non-cash stock comp expense as we deployed stock comp pretty significant this year as an incentive for our people and retention to the long term. That combination actually makes up the majority of the increase in these R&D expense.

There was some additional—just, we spent some money on improving some of our facilities and just some basic non-CapEx maintenance associated with it as well as associated with some of the work that we're doing to accelerate our non-ethanol microbe development. There have been some third party contract expenses associated with that as well.

Leo Mariani

Okay. So, it sounds like you're saying second half of '23 R&D is pretty similar to first half, if I'm hearing you right.

Geoff Trukenbrod

Pretty steady state for us through the year, yes.

Leo Mariani

Okay. Thank you.

Operator

Thank you. The next question comes from the line of Thomas Meric from Janney Montgomery. Please go ahead.

Thomas Meric

Good morning. Thanks for taking the time. Just wanted to dig in on Brookfield a little bit with a few questions. How many pipeline projects are attributable to Brookfield and where are those projects in terms of stage of development, especially relative to FID?

Jennifer Holmgren

Thank you for the question. On Brookfield, we have quite a number of projects and we expect to—and we haven't named them yet. They are all in Europe or North America, and we expect to get a couple of them to FID by the first quarter of next year.

We've made quite a bit of investment. We've hired a leader for that group. As you know, Aura comes to us from Shell and she is leading the Brookfield pipeline work. That team is focused on getting at least one project to FID either by the end of this year or early next year.

Thomas Meric

Great. Thank you. Stepping back a little bit, with the Brookfield partnership, do you think it's a blueprint for other potential arrangements to do something similar, or is this maybe more one-off in nature? And kind of the follow-up to that is, do you think there are other types of commercial or financing partnerships coming in the next few years?

Jennifer Holmgren

Absolutely. I believe Brookfield is just the first of multiple partnerships that are focused on investment and infrastructure, ie. helping us build out plants. We do have multiple such discussions in the pipeline and I think you'll see more of such partnerships across the globe.

As you well know, Europe and North America is what Brookfield is focused on, and we are looking of course to scale in other parts of the world. So, having other partners across the world is going to be quite important for us and we are working on that.

I do think it's worth—since you asked about multiple types of partnerships, there is the financing and infrastructure partnerships that we've just discussed in relation to Brookfield, but we've also been building our channels to market. I think you saw an announcement with Technip. They are going to help us create demand in the petrochemical sector. You also saw a partnership with Primetal Technologies. They're working with us to create a pipeline, a stronger pipeline in steel and ferroalloy. And NextChem, who is one of our partners in the municipal solid waste space is also channel to market the municipal solid waste projects.

So, we're creating multiple types of channels to market: one, which is the financing side, but the other which is actually the people who are actually embedded in those industries pulling us along.

Thomas Meric

Great. Thank you. Just two quick ones on Freedom Pines. I wonder if you could update us on what's needed for mechanical completion this year specifically. Then going forward, as it's operating what milestones do you need to hit to increase your equity stake if you want to?

Jennifer Holmgren

Great question. Let me tackle the milestones first.

The milestones for our equity stake depend on other investors taking up license. So as Freedom Pines Fuel comes into play—and as you know LanzaJet is already developing projects with their current investors. The Dragon Project, as an example with LanzaTech, they're working also with Mitsui, British Airways and Shell on developing a pipeline of projects. When those investors pick up a license, that is when LanzaTech's equity investment goes up. For every license that one of the investors takes for the first licenses that they take, our equity shareholding goes up. That will be happening over the next six to nine months.

The second part of the question is what's required for mechanical completion. Right now LanzaJet is fully funded through mechanical completion and start-up, so no cash will be required. Much of the—all of the inside battery limits, the actual alcohol-to-jet plant is already in modules and being installed. We are in the last stages of installing that. Then the rest is the additional work, the outside battery limits, so (inaudible), etc. That's also being installed. There should be n—there should be nothing to stop that plant from being mechanically complete by the end of this year. All the contracts are in play, all the construction is in play. Tremendous progress by the LanzaJet team.

Thomas Meric

Great. Thank you. That's it for me.

Operator

Thank you. The next question comes from Pavel Molchanov from Raymond James. Please go ahead.

Pavel Molchanov

Thanks for taking the question. Maybe kind of zooming on the steel and all project in Belgium, a pretty high profile project for you guys. First, can we just get an update on kind of where the facility is in the commissioning process and what's going to happen between now and the end of the year?

Jennifer Holmgren

Thanks, Pavel. Yes, that's a high profile project sitting in Europe, and also because ArcelorMittal is the largest western steel company.

We have completed the construction of the plant, so it's in hot works commissioning stage. That's really the last stage. In fact, we started the inoculator and produced ethanol in June, so we know all of that part of the plant is working quite well. We expect to complete all the hot commissioning work in the next, I would say 30 to 60 days max, and then start up the bioreactors. We will certainly be—should be operating in the fourth quarter of this year.

Pavel Molchanov

Financially, in terms of LanzaTech actual income statement, what changes as the project moves into production, as you said in Q4?

Jennifer Holmgren

Right. The key change will be that we will be receiving licensing revenues from the production of ethanol. That will be the biggest change that you will see.

Do you want to add anything to that, Geoff?

Geoff Trukenbrod

No. I was just going to say, yes, in addition—as Jennifer mentioned, ArcelorMittal is set up and as you heard in my remarks it is a first-of-a-kind plant, being the first in Europe, so the royalty economics are slightly different than what we see in the rest of our pipeline, but we will start seeing royalty revenues associated with production of that plant. Again, it's starting up closer to the end of the year so they won't be particularly material this year until we're seeing material volumes coming off that plant. But they are also the consumable side, the microbes and media, and then we do have some of our other recurring revenue products like our software and services.

Pavel Molchanov

Okay. Maybe just kind of zooming out for a moment, the whole green steel kind of space is pretty nascent. Obviously you guys have been involved with Shougang in China for quite a while. When do you think steel production in the U.S. will kind of jump on this bandwagon? Because it feels like it's very Europe-centric with maybe a handful of Chinese companies doing that as well?

Jennifer Holmgren

I think when I think about green steel, there has already been major transition in the U.S. steel sector towards recycling scraps, etc., versus actually running electric arc furnaces and such. I think you know this area quite well, Pavel, so the fact is there's only a couple of coke oven type linked steel plants in the U.S. and so decarbonizing those is going require something like to our technology, something like carbon capture and sequestration, or what they're doing in other parts of the world, which is transitioning to hydrogen. But so much of the steel sector in the U.S. is based on technologies which don't quite produce carbon monoxide, carbon dioxide directly because of the type of steel that they do produce. So it's quite a different landscape.

I'd love to hear your views on that because I know you've been looking at green steel.

Pavel Molchanov

Yes. Well, you guys are involved with Arcelor which is by far the most active globally in the transition. So, good. We'll look forward to getting updates on Belgium over the next six months. Thanks again.

Operator

The next question comes from Tom Curran from Seaport Research Partners. Please go ahead.

Tom Curran

Good morning. Just two follow-ups on LanzaJet. First, would you provide us with a progress update and some color on offtake agreements or other anchor SAF buyers for the Freedom Pines plant? Just how much of that 10 million gallons per year of capacity is already contracted?

Jennifer Holmgren

All of it. All of it. The investors in LanzaJet took all the fuel, so there was nothing left to provide to anybody else. It's 100%.

Tom Curran

I'm not surprised to hear that, which is kind of a nice segue into my next question which is, you know, for SAF there seems to be a lot of consternation about the availability dilemma. The idea that the drop in supply side remains resource constrained when it comes to economically viable options or making drop-in SAFs and therefore global SAF production is fated to continue to fall well short of the aviation industry's ambitious consumption targets.

Given the abundance, diversity and lack of human need for the potential feedstock for LanzaTech's waste-based ethanol technology, it seems as if combining a license for a LanzaTech biorefining plant with a license for LanzaJet's AtJ process could take a lead role in solving for availability. What do you think are the main governing factors in determining how fast such a biorefining plus AtJ combination could grow? Where are you focused for maximizing that potential growth rate?

Jennifer Holmgren

Thank you for that question. Absolutely, that's the next stages in our pipeline as you well know, the combined waste-based ethanol plus the alcohol-to-jet technology. I think you saw the announcement that Air New Zealand and the New Zealand government have selected the LanzaTech/LanzaJet solution, at least for the next feasibility stage. You probably saw that Tadweer in the Middle East, that project is municipal solid waste to aviation fuel, and so that combines both LanzaTech and LanzaJet. We are very, very focused on that and I think the key drivers will be, one, we're going to go a lot faster as soon as Freedom Pines Fuels is built out. That will give a lot of certainty. Then the second piece of that is going to be as we continue to drop the price on the waste-to-ethanol of the portfolio, which is something—as you know, the more plants we build, the cheaper it will be to build the next plant. So, I think we'll start to see ourselves go very fast next year, but I think we already have those projects in the pipeline. We've announced only a couple of those, Tadweer and New Zealand, but there are multiples of that that are in the early stages and feasibility stages.

Tom Curran

Got it. Thank you for taking my questions.

Operator

Thank you. The next question is from the line of John Annis from Stifel. Please go ahead.

John Annis

Good morning all and thanks for taking my questions. For my first one, as you near the expected start-up of three additional facilities this year, could you offer any high level commentary on some of the learnings in terms of cost savings and reducing build times that you've achieved as you move from the first commercial plant in 2018 to these facilities slated to enter operations this year? And could you perhaps characterize whether engineering improvements and/or changes to bacteria design are driving any efficiencies?

Jennifer Holmgren

Right. In the replication which is what we're doing right now, the efficiencies come from being able to work with equipment vendors and EPCs that understand our technology can go faster and can offer reduced costs because they know that we're replicating, right? They're not going to sell one compressor; they're going to sell multiple because they know we have a pipeline. So, a lot of the costs that we're seeing where we're coming down right now are just based on simple replication.

Now, as we've also announced, we have worked on our second-generation bioreactor. We have demonstrated that at Suncor in the field, and that will give us significant savings because it will improve not just the cost of the plant—it will reduce the cost of the plant, but it will also at the same time improve yield. So that combination will improve the total IRR of the plant.

You'll see that our improvements come from a combination of technology, like the second-generation bioreactor, and fundamentally just from replicating. The more you build, the cheaper everything gets, right? Just like you saw in solar, right? It's that part of the model and that part of the business that really helps.

John Annis

Makes sense. For my follow-up, you highlighted in your prepared remarks that you are ahead of schedule in demonstrating the production of isopropanol microbes at scale, and there is certainly a large end market opportunity that you highlighted. Maybe using Slide 15 as a basis, could you frame how you're looking at the timeline of progressing these microbes from the demonstration stage to commercial operation?

Jennifer Holmgren

Absolutely. Actually, we jumped on an opportunity. The plant at Suncor, the plant that we were testing with Suncor, our second-generation bioreactor, we had completed all the ethanol work that we were doing there with that reactor ahead of schedule, which is what allowed us to jump on testing our isopropanol microbe there. The isopropanol microbe has done very, very well in our lab in our pilot. It is looking quite good at the second-generation bioreactor as well. If things continue as expected, we should have that microbe ready for commercial use next year. That is the timeline we have for that microbe.

Quickly on the heels of that will be our acetone-producing microbes, which as you know will be very useful in acrylics and other applications. That's what's next in the pipeline, that again is in the 18 to 24 commercial timeline. Twenty-four months, sorry.

John Annis

I appreciate all the color.

Jennifer Holmgren

Yes. Thank you so much.

John Annis

Thank you.

Operator

Thank you. This concludes our question-and-answer session. I would now like to turn the conference back to Jennifer Holmgren for any closing remarks. Thank you and over to you.

Jennifer Holmgren

Thank you so much to everybody for joining us and for supporting our journey to create a different carbon economy. I really appreciate your taking the time, especially during the first year of our public presence. Thanks again for joining us.

Operator

Thank you very much. Ladies and gentlemen, the conference has now concluded. Thank you for attending today's presentation. You may now disconnect your lines.

