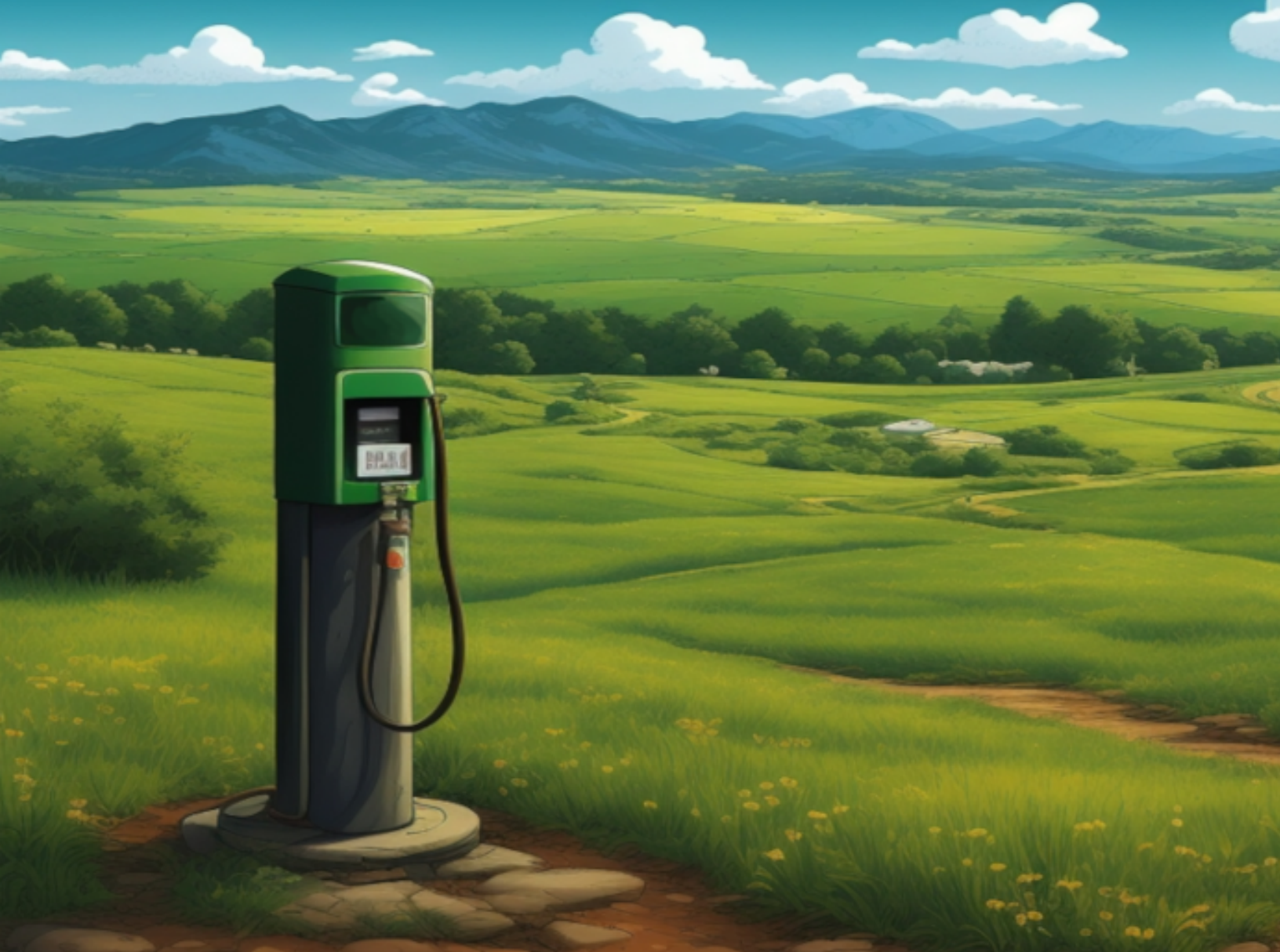




Sustainable Transportation Fuels

Low-Carbon Fuels Industry

Company Description

Sustainable Transportation Fuels (STFuels) is a mission-driven, sustainable biofuels manufacturer, utilizing the power of the azolla fern to produce biocrude oil for transportation fuel production. STFuels is currently a startup organization in the research and development phase. STFuels plans to construct an “all-in-one” facility where azolla is continuously cultivated, harvested, and converted to biocrude oil, and any co-products are used to produce synthesis gas (syngas) for on-site power generation and off-site fuel generation. STFuels envisions a fully closed-loop, self-sufficient, sustainable biocrude production plant with valuable co-products and zero need for outside energy and material inputs.

Headquarters	Las Vegas, Nevada, USA
Founded	2023
Business model	LLC
Employees	3
Intellectual property	1 patent pending
Website	www.stfuels.com

Alignment with the United Nations’ Sustainable Development Goals (SDGs)



Affordable and Clean Energy



Industry, Innovation and Infrastructure



Climate Action

STFuels GHG Footprint*

-296 kgCO₂e

per barrel of biocrude oil

Results provided in this report are based on theoretical production process flows and associated efficiencies provided to Boundless by STFuels.

*GHG Footprint is based on a cradle-to-gate system boundary that accounts for biogenic sequestration and syngas as a co-product.

Boundless Analysis

- ▶ This report compares STFuels’ biocrude oil to conventional petroleum crude oil as well as algae-based biocrude oil and biocrude from a combination of wastewater sludge and algae.
- ▶ STFuels’ biocrude oil is produced via hydrothermal liquefaction of biomass.
- ▶ Boundless evaluated the environmental performance of STFuels’ biocrude oil as well as the competing technologies, specifically associated with their Greenhouse Gas (GHG) Footprint per barrel (bbl) of crude oil.
- ▶ STFuels’ biocrude oil has a GHG Footprint of -296 kilograms of carbon dioxide equivalent (kgCO₂e) per bbl, or -50.5 gCO₂e per megajoule (MJ), which is 610% lower than conventional petroleum crude oil.
- ▶ STFuels’ biocrude oil also yields a lower GHG Footprint than competing hydrothermal liquefaction processes, which include biocrude produced solely through microalgae as well as a combination of wastewater and algae.

Management Team

- ▶ Arnold Keller, Founder, Process Developer, Joint Patent developer, and acting CEO, is an experienced process consultant engineer in the fields of gas processing, gasification, power cycles, and fuel production and processing from fossil fuels. Keller has specific relevant experience that includes process engineering with practical front-end design experience in synthetic fuel production via Fischer-Tropsch and methanol conversion through zeolite catalysis. The IP is a unique combination of many different process technologies that are very familiar to Keller.
- ▶ Chris Wallsgrove, Consultant Process Designer, Operations Chief, is a world-renowned consultant on ethylene plant design, refinery operations and first of a kind design and startups. He has over 50 years' experience with both EPC and vertically integrated oil companies. Chris brings extensive hands-on experience and will be leading the design team from pre-FEED through to start up.
- ▶ Michael Keller, Investor Relations, is the co-developer of the IP patent application. His role will also include marketing in the early days of the start-up.

Technology

- ▶ STFuels is developing a low-carbon production pathway for biofuels. Their process aims to produce sustainable biocrude oil as well as renewable syngas consisting of hydrogen, carbon monoxide, and carbon dioxide, which can then be transformed into various renewable transportation fuels using proven commercialized technology.
- ▶ STFuels' patent pending Combination Process aims to turn atmospheric carbon dioxide, water, and light into renewable biocrude oil thereby reducing the overall carbon footprint of fuel production. The process involves biomass cultivation, hydrothermal liquefaction, and gasification, which then produce biocrude oil and syngas. A portion of this syngas is intended to be used for on-site power generation to eliminate any need for off-site power generation and delivery.

Operations and Milestones

- ▶ STFuels is headquartered in Las Vegas, Nevada, USA.
- ▶ STFuels has filed for US and overseas patents. The process involves a combination biomass consisting of algae and azolla plants, or other highly productive biomass, which is mass cultivated in a concentrated space to produce a biocrude oil to feed existing regular fossil fuel-based oil refineries.

Current Operations



Environmental Highlights

Summarized below are the most relevant impact categories and codes that refer to the United Nations' Sustainable Development Goals. The present section highlights the most important factors that explain how this technology impacts the environment and society.



Low-Carbon Transportation Fuel

STFuels' biocrude technology provides an alternative to petroleum crude oil technologies for efficient carbon-negative production. Their biocrude production technology is required to encourage a rapid transition to renewable energy and fuel technologies. STFuels' Combination Process will encourage the growth of renewable transportation fuels and facilitate the transition to a net-zero future. A production process which results in carbon-negative transportation fuels will drastically improve emissions in the transportation sector, which account for approximately 29% of total emissions in the United States.¹

Relevant code: [SDG 7](#), Affordable and Clean Energy.



Resource Use Efficiency

STFuels' technology provides sustainable crude oil production while reducing global dependence on oil-derived, non-renewable fuel sources. STFuels' goal to retrofit decommissioned coal infrastructure into a sustainable biocrude production facility will give a new life to antiquated infrastructure systems. UN SDG 9 includes target 9.4, which states the need to "upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies." STFuels' Combination Process relies on adapting and repurposing pressurized coal gasification systems and combining them with pyrolysis or hydrothermal processing methods like hydrothermal liquefaction. Coal-dependent power plants across the United States were predominantly built in the 1960's and 70's and are reaching the end of their 50-year life span; companies like STFuels can provide an alternative second-life for these facilities.

Relevant code: [SDG 9](#), Industry, Innovation and Infrastructure.



Decarbonization

STFuels' Combination Process has a theoretical GHG Footprint of -296 kgCO₂e per barrel of biocrude, which is 610%, 179%, and 76.2% lower than the competing petroleum, microalgae, and wastewater crude production routes, respectively. STFuels' theoretical technology would decarbonize the crude oil industry while promoting the growth of renewable fuel sources. To align with climate initiatives and mitigation targets, a rapid transition to low-carbon transportation fuel technologies will be required. STFuels' process addresses the increasing demand for alternative crude oil production pathways with a lower carbon alternative.

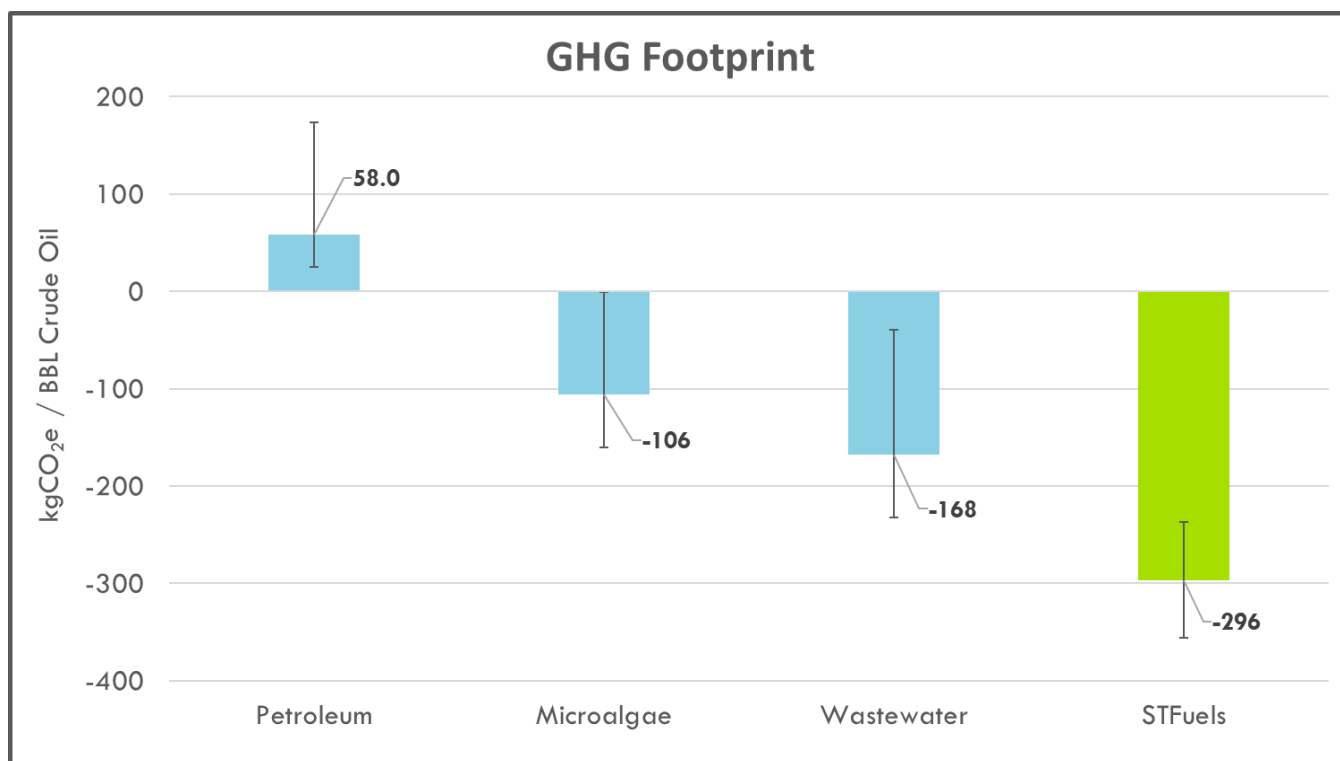
Relevant code: [SDG 13](#), Climate Action.

¹ EPA. (n.d.). Carbon pollution from transportation | US EPA - U.S. environmental ... Transportation, Air Pollution, and Climate Change.
<https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation>

Greenhouse Gas Footprint

GHG Footprint is a measure of the cradle-to-gate GHG emissions resulting from the production of crude oil; it is reported in kgCO₂e per bbl of crude oil. GHG Footprint accounts for biogenic carbon sequestration due to biomass cultivation as well as avoided emissions from co-product use.

- ▶ STFuels has a theoretical cradle-to-gate GHG Footprint of -296 kgCO₂e per bbl of crude oil produced, or -50.5 gCO₂e/MJ, which is lower than all competing technologies identified in this assessment.
- ▶ 77.4% of STFuels' GHG Footprint is attributed to the biogenic sequestration associated with biomass cultivation.
 - For this assessment, Boundless assumed a biocrude oil carbon content of 63.2%.²
- ▶ Due to the cyclical nature of this proposed technology, and an assumed 99.9% efficiency, there are assumed to be net-zero emissions associated with the production phase as any direct CO₂ emissions during production will originate from biogenic sequestration and any "waste" streams will be reused within the process.
- ▶ It is estimated that approximately 15.5% of the syngas that is co-produced during the process is used to generate electricity on-site to power the production of the plant, and the remaining 84.5% is converted into transportation fuels.
- ▶ STfuels' Combination Process technology has a theoretical GHG Footprint that is 610%, 179%, and 76.2% less than the competing petroleum, microalgae, and wastewater crude production routes, respectively.



² Goswami, G., Makut, B. B., & Das, D. (2019). Sustainable production of bio-crude oil via hydrothermal liquefaction of symbiotically grown biomass of microalgae-bacteria coupled with effective wastewater treatment. 9(1), 15016–12. <https://doi.org/10.1038/s41598-019-51315-5>

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