Western Slope
Sustainable Aviation Fuel Feasibility Project

Executive Summary & Background (V1.00)

SUSTAINABLE AVIATION

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EXECUTIVE SUMMARY

The Western Slope Sustainable Aviation Fuel (SAF) Feasibility Project was initiated by Pitkin County, Mesa County, Delta County, and Eagle County (the Partners), with support from the Colorado Department of Local Affairs (DOLA). The Partners sought to understand whether a SAF production pathway could be viable in the region, given growing interest in decarbonizing aviation and supporting long-term economic development across the Western Slope.

The project advanced in two stages. First, Task 1 assessed the availability, reliability, and sustainability of SAF-approved feedstocks across the Western Slope, covering a wide range of potential options. While the region contains meaningful feedstock potential, the assessment identified significant barriers related to long-term supply certainty, scale, aggregation across jurisdictions, institutional coordination, and the absence of midstream infrastructure. Recognizing these challenges, the Partners chose not to advance directly into a full techno-economic analysis. Instead, they initiated a Revised Scope of Work to engage directly with SAF producers, technology licensors, and feedstock developers to better understand whether any practical solutions or alternative pathways could overcome the barriers highlighted in Task 1.

The discussions conducted under the Revised Scope of Work provided clear and consistent insights. Industry partners confirmed that while the Western Slope has meaningful resources, each pathway carries constraints that are politically, financially, or logistically difficult to overcome under current conditions. Forestry resources, though abundant, depend on federal access and large-scale logistics systems that are not in place today. Camelina shows agronomic promise but would require county-led agricultural development and new processing infrastructure to become viable. Municipal solid waste (MSW) volumes within each county are insufficient to support SAF production at commercial scale, and cross-jurisdictional MSW aggregation would be politically and logistically challenging. Taken together, these discussions reinforced that no pathway is currently viable without substantial structural changes, efforts the Partners concluded extend beyond the scope of the DOLA-funded project. Accordingly, the study concludes at the completion of the Revised Scope of Work.

Although no immediate pathway to commercial SAF production exists under current conditions, the analysis highlights several areas that may merit future attention if the Partners choose to revisit SAF-related opportunities. Forestry could become suitable for renewed evaluation if long-term supply agreements and logistics systems are strengthened. Oilseed development may hold potential if agricultural counties lead grower engagement and if a regional crushing facility is established. The Eagle–Syntech project may also offer a useful opportunity to observe waste-to-products performance and gather operational data in a local context.

This combined report provides a clear and unified foundation for regional decision-making. The full findings of Task 1 are presented in Annex 1, and the analysis from the Revised Scope of Work is included in the main body of the document. Together, these components offer an evidence-based understanding of the Western Slope's SAF landscape and the conditions that would need to be in place before any future pathway evaluation could proceed.

BACKGROUND

The Western Slope Sustainable Aviation Fuel (SAF) Feasibility Project was initiated jointly by Pitkin County, Mesa County, Delta County, and Eagle County (collectively referred to in this report as "the Partners") with financial support from the State of Colorado through the Department of Local Affairs (DOLA). The Partners launched this effort to explore region-specific opportunities to reduce aviation-related emissions, support local economic development, and better understand the Western Slope's potential role in Colorado's emerging low-carbon fuels landscape.

The Partners released a request for proposals in late 2024, seeking a qualified consultant to evaluate the technical, logistical, and economic feasibility of SAF production across the Western Slope. The intent of the RFP was to conduct a structured, evidence-based assessment of the region's approved feedstocks, infrastructure, and market conditions, leading to a recommended development pathway or determination that no viable pathway existed.

Task 1 – Regional Feedstock Assessment

Under the original Scope of Work, the project began with Task 1, a comprehensive evaluation of all viable SAF-approved feedstocks available across the Western Slope. This included forestry residues, agricultural products and byproducts, municipal solid waste (MSW), and other biomass resources. The analysis also examined sustainability characteristics, permitting considerations, aggregation challenges, and long-term reliability of supply.

Task 1 confirmed that the Western Slope contains meaningful quantities of several different feedstocks, but no single feedstock demonstrated the scale, consistency, or long-term reliability required to anchor a commercial SAF project. Each feedstock showed potential but also faced specific barriers, including institutional constraints on federal lands, lack of midstream infrastructure, multi-county MSW aggregation challenges, and the early-stage nature of regional oilseed markets. Although many barriers could theoretically be addressed, the Partners concluded that none appeared surmountable in the near term without major structural changes or investments.

Transition to a Revised Scope of Work

Given the outcomes of Task 1, the Partners determined that proceeding immediately into a full techno-economic analysis (TEC) would not provide meaningful value. Instead, they agreed to refine the project's direction through a series of targeted discussions with SAF producers, technology licensors, and feedstock developers to better understand:

- how commercial SAF developers view the Western Slope,
- what minimum scale and infrastructure conditions they require,
- what risks or constraints are most material to investment decisions, and
- whether any feasible SAF pathway could emerge if certain barriers were addressed.

This decision resulted in the Revised Scope of Work, focused on stakeholder engagement with six leading organizations representing HEFA producers, MSW/thermochemical technology providers, oilseed developers, and potential midstream partners. The purpose of this second phase was to gather industry perspectives on the constraints identified in Task 1 and assess whether any feasible investment pathway remained plausible for the region.

This background frames the rationale and structure of the Western Slope SAF Feasibility Project, clarifying both the region's potential and the constraints that shaped the study's scope. As such, it provides the context needed to understand the study's conclusions and the conditions that would need to be in place to support future consideration of SAF deployment in the Western Slope.

Western Slope
Sustainable Aviation Fuel Feasibility Project

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Date:	12.16.2025
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Executive summary

The **Western Slope Sustainable Aviation Fuel (SAF) Feasibility Project** is a strategic initiative aimed at exploring the potential for establishing a regional SAF supply chain in Western Colorado. This first-phase assessment (Task 1) evaluates the availability, sustainability, and logistical feasibility of various feedstocks to support SAF production through pathways such as hydrotreated esters and fatty acids, alcohol-to-jet, gasification/Fischer-Tropsch, pyrolysis, and power-to-liquid technologies.

Key Findings

1. Diverse but Dispersed Feedstock Base
Western Colorado presents a varied portfolio of SAF feedstocks, including used cooking oil, animal fats, agricultural residues, non-food oilseeds (e.g., camelina), forestry byproducts, municipal solid waste, and industrial gases. While technically viable, available and potential feedstocks must be aggregated or supplemented with volumes from other regions to support a commercial-scale SAF refinery. For example:

Camelina, Soybean, and Canola Oil:

- Camelina is a high-potential SAF feedstock. On the Western Slope, optimal conditions could yield 4,774 metric tons of grain annually, and statewide production could reach 307,240 metric tons, enough to meet 32.9% of the refinery's feedstock demand. Additional oil-grains, including soybean and canola, could supply 174,096 and 148,770 metric tons, respectively, covering another 40.7% of SAF feedstock needs. Combined, these feedstocks could meet roughly 68% of the requirements for a commercial-scale 776,000-metric-ton-per-year refinery, demonstrating the viability of a multi-feedstock strategy. Remaining volumes could be sourced from inland states using the interconnected rail network.

Forestry Residues:

- Western Colorado produces 889,500 metric tons of forestry biomass each year, and its forests contain an estimated 10,400,000 standing dead or high-risk trees. These volumes appear sufficient for a commercial scale SAF facility that uses the Fischer Tropsch conversion process. Incorporating this material into SAF production offers environmental and economic benefits, contributing to wildfire mitigation while supporting rural economies. The suitability of the Alcohol-to-Jet pathway may be best assessed in collaboration with leading technology providers due to the confidentiality maintained on specific volumes other input needs.

Municipal Solid Waste - MSW

- Delta, Mesa, Pitkin, Eagle, & Montrose counties generate 534,300 metric tons of MSW annually, with an estimated 304,530 metric tons consisting of organic fraction suitable for SAF production. Although individual landfills do not produce enough feedstock independently, regional aggregation of the organic fraction of municipal solid waste could support a medium-scale SAF refinery, providing a scalable, waste-to-energy pathway that aligns with circular economy principles.

Opportunities for Economic Development

Beyond feedstock availability, SAF deployment presents a major economic opportunity across agriculture, forestry, waste management, transportation, and fuel processing. By investing in feedstock aggregation, processing infrastructure, and supply chain optimization, Western Colorado can fill workforce gaps left by declining coal, oil, and gas industries, creating new employment opportunities while advancing national decarbonization goals.

Stakeholder Engagement and Local Support

Extensive engagement with local farmers, industry experts, and waste management professionals revealed enthusiastic interest in SAF feedstock production, given the right economic conditions. Farmers welcomed camelina as a rotational crop, recognizing its low water requirements and compatibility with existing equipment. Forestry industry representatives saw value in repurposing residues, and waste management professionals acknowledged MSW's viability for SAF, provided that infrastructure improvements were made.

Moving Forward

The findings reinforce Western Colorado's readiness to participate in SAF production, demonstrating strong feedstock potential, economic incentives, and local willingness to engage in the SAF supply chain. While additional feedstock sourcing from neighboring states may be necessary, this does not diminish the feasibility of SAF refinery deployment in Western Colorado. Instead, it strengthens regional collaboration, ensuring a resilient, diversified SAF industry that benefits local economies while advancing sustainable aviation. Moreover, Pitkin County's commitment to reducing emissions from aviation operations underscores the urgency of transitioning to low-carbon fuel alternatives. SAF development in the region would directly align with these environmental goals, helping airports, including Aspen/Pitkin County, Rifle/Garfield, Grand Junction, and Eagle Regional Airports, move toward more sustainable fuel options while supporting broader decarbonization efforts in the aviation sector.

The following sections provide a detailed analysis of feedstock availability, sustainability considerations, and logistical requirements to guide Western Colorado's SAF development strategy.

Content

Executive summary 1
List of Tables 5
List of Figures 6
List of Acronyms 7
1 Background 9
1.1 Objective 9
1.2 Statement and Detailed Approach to Service: 9
1.3 Deliverables 11
1.4 Workplan – General Overview 12
2 Introduction 16
3 Existing and Potential Feedstocks 17
3.1 Used cooking oil - Overview 17
3.1.1 Sustainability Analysis 18
3.1.2 Feedstock Analysis 18
3.1.3 Opportunities and Considerations 19
3.1.4 Conclusion and Key Findings 19
3.2 Animal fats - Overview 20
3.2.1 Sustainability Analysis 21
3.2.2 Feedstock Analysis 22
3.2.3 Opportunities and Considerations 23
3.2.4 Conclusion and Key Findings 23
3.3 Camelina - Overview 24
3.3.1 Sustainability Analysis 25
3.3.2 Feedstock Analysis 25
3.3.3 Expanded Regional Potential for Camelina Production 27
3.3.4 Opportunities and Considerations 28
3.3.5 Conclusion and Key Findings 29
3.4 Additional oilseed crops 31
3.4.1 Carinata - Overview 31
3.4.2 Soybean and Canola - Overview 34
3.5 Agricultural Residues - Waste from Sweet corn, Corn stover and wheat straw 43

SUSTAINABLE AVIATION

3.5.1 Sustainability Analysis 43
3.5.2 Feedstock Availability 44
3.5.3 Regional Collection and Infrastructure 45
3.5.4 Opportunities and Considerations....45
3.5.5 Conclusion and Key Findings 45
3.6 Forestry residues - Overview 46
3.6.1 Sustainability Analysis 47
3.6.2 Feedstock Analysis....48
3.6.3 Opportunities and Considerations....51
3.6.4 Conclusions and Key Findings 52
3.7 Municipal solid waste - Overview 52
3.7.1 Sustainability Analysis 53
3.7.2 Feedstock Analysis....54
3.7.3 Opportunities and Considerations....57
3.7.4 Conclusion and Key Findings 58
3.8 Wastewater - Overview 59
3.8.1 Sustainability Analysis 59
3.8.2 Feedstock Analysis....60
3.8.3 Opportunities and Considerations....60
3.8.4 Conclusions and Key Findings 61
3.9 Industrial Gases - Overview 61
3.9.1 Applicable Conversion Technologies and Required inputs....62
3.9.2 Sustainability Analysis 63
3.9.3 Feedstock Analysis....64
3.9.4 Opportunities and Considerations....66
3.9.5 Conclusions and Key Findings 67
4 Feasibility Matrices – Featured Feedstocks....68
5 Conclusions....70
References....72
Annex I – Remote Stakeholder Interaction Record Keeping 0

SUSTAINABLE AVIATION

List of Tables

Table 1 – Feedstock Categories for SAF processing........10
Table 2 - Preliminary list of relevant stakeholders........13
Table 3 - Table of Milestones........15
Table 4 - LCA results for UCO HEFA pathway [gCO2e/MJ]........18
Table 5 - Regional vs. National tallow recovery potential........23
Table 6 - LCA results for camelina HEFA [gCO2e /MJ]........25
Table 7 - Camelina production potential in the Western Slope, CO........26
Table 8 - Western Slope - potential camelina oil production........27
Table 9 - Central Colorado - potential camelina oil production........27
Table 10 - Eastern Colorado - potential camelina oil production........28
Table 11 - Colorado Statewide - potential camelina oil production........28
Table 12 - - Camelina Cultivation Potential in Neighboring States........30
Table 13 - - LCA result for carinata HEFA pathway [g CO2e/MJ]........32
Table 14 - - Estimated oil yields from spring crops in the Western Slope of Colorado........35
Table 15 - Estimated oil yields from spring crops in Central Colorado........37
Table 16 - - Estimated Oil Yields from Spring Crops in Eastern Colorado........38
Table 17 - Regional Contribution of Oilseed Feedstocks to HEFA Refinery Demand........39
Table 18 - Annual Canola & Soybean Oil Yield Statewide in CO and Share of HEFA Refinery Demand........41
Table 19 - Potential canola, soybean, and camelina annual oil yields CO Statewide........42
Table 20 - Estimated Crop Residue Volumes for SAF in the Western Slope Region........44
Table 21 – Agricultural Residue needed to Operate a FT-to-SAF Refinery........44
Table 22 - - Agricultural Residue needed to Operate a Pyrolysis SAF Refinery........45
Table 23 - LCA for or forest residue FT pathways [gCO2e /MJ]........47
Table 24 - LCA for the forest residue iso-butanol ATJ pathway [gCO2e/MJ]........47
Table 25 - Forestry Residue needed to Operate a FT-to-SAF Commercial Refinery........48
Table 26 - Forestry Residue needed to Operate a Pyrolysis-to-SAF Commercial Refinery........48
Table 27 - Forestry Residue needed to Operate a AtJ-to-SAF Commercial Refinery........49
Table 28 - Forestry Residues for SAF processing - Western Slope Opportunity........50
Table 29 - Dead tree biomass required for a FT SAF plant........50
Table 30 - MSW MT needed to Operate an MSW-to-SAF Commercial Refinery........53
Table 31 - LCA results for MSW [gCO2e /MJ]........54
Table 32 - Western Slope Landfill Volumes........55
Table 33 - Wastewater Biosolids and SAF output........60
Table 34 - CI of PTL SAF made from industrial gas........63
Table 35 - CO_2 needed to operate a PtL -SAF Commercial Refinery........64
Table 36 – Biggest GHG emitters in Colorado........65

List of Figures

Figure 1 – Simulation of SAF's sustainability certification pathway 11
Figure 2 - Simulation of a Feasibility Matrix for Forest Residues 12
Figure 3 - UCO Prices vs. HEFA Feedstock Cost Threshold 19
Figure 4 - Estimated U.S. UCO Allocation by Sector 20
Figure 5 - LCA results for tallow HEFA pathways [gCO2e/MJ] 21
Figure 6 - Current Uses of U.S. Rendered Tallow 22
Figure 7 - Tallow Market Prices vs. SAF Feedstock Affordability 24
Figure 8 – Estimated oil yield for Western Slope 36
Figure 9 - Estimated oil yields from Central Colorado 37
Figure 10 - Estimated oil yield for Eastern Colorado 38
Figure 11- Freight corridors linked to CO from neighbouring states 40
Figure 12 - Potential canola, soybean, and camelina annual oil yields CO Statewide – bar chart 42
Figure 13 - Are covered by the Larimar Conservation District 50
Figure 14 - Mesa County Landfill 55
Figure 15 – LanzaJet's multi-feedstock SAF conversion process 57
Figure 16 - Graphical representation of the Colorado's GHG Emitters 65
Figure 17- SAF Production Costs Per Production Pathway 66

SUSTAINABLE AVIATION

List of Acronyms

Acronym	Full Form
ASTM	American Society for Testing and Materials
AtJ	Alcohol-to-Jet
CAEP	Committee on Aviation Environmental Protection
CCUS	Carbon Capture, Utilization, and Storage
CDA	Colorado Department of Agriculture
CDE	Colorado Department of Energy
CDPHE	Colorado Department of Public Health and Environment
CEODIT	Colorado Office of Economic Development and International Trade
CI	Carbon Intensity
CO2	Carbon dioxide
COGA	Colorado Oil and Gas Association
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CSP	Concentrating Solar Power
CSU	Colorado State University
CTL	Coal-to-Liquid
DOE	Department of Energy
EC	European Commission
EIA	US Energy Information Administration
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
eSAF	electrofuels based Sustainable Aviation Fuel
EU	European Union
FBO	Fixed-Base Operator
FEED	Front End Engineering and Design
FOAK	First of a Kind
FT	Fischer-Tropsch
GEMM	Greenhouse Gas Emissions and Energy Management for Manufacturing
GHG	Greenhouse Gases
GJEP	Grand Junction Economic Partnership
GMUG	Grand Mesa, Uncompahgre and Gunnison
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Technologies
GTL	Gas-to-Liquid
H2	Hydrogen
HEFA	Hydroprocessed Esters and Fatty Acids
HTL	Hydrothermal Liquification
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization

ILUC	Indirect Land Use Change
ISCC	International Sustainability and Carbon Certification
kWh	kilo watt hour
LCA	Life Cycle Assessment
LFG	Landfill gas
MAAD	Methane Arrested Anerobic Digestion
MGPY	Million Gallons Per Year
MSW	Municipal Solid Waste
MT	Metric Tonne
MW	Megawatt
NBC	Non-Biogenic Content
OFMSW	Organic Fraction of Municipal Solid Waste
PFR	Primary Forestry Residues
PPP	Power Purchase Agreements
PtL	Power-to-Liquid
RD	Renewable Diesel
RFS	Renewable Fuel Standard
RIN	Renewable Identification Number
RNG	Renewable Natural Gas
RoT	ICAO Rule of Thumbs
RSB	Roundtable on Sustainable Biomaterials
SAF	Sustainable Aviation Fuel
SFR	Secondary Forestry Residues
TRL	Technology Readiness Level
UK	United Kingdom
USD	United States Dollar
USDA	United States Department of Agriculture
USFS	US Forest Service
USG	US gallon

1. Background

The **Western Slope Sustainable Aviation Fuel Feasibility Project** is a collaborative effort aimed at reducing aviation-related carbon emissions by developing a regional Sustainable Aviation Fuel (SAF) supply chain. The project aligns with the Grand Junction Economic Partnership's (GJEP) mission to enhance economic vitality and sustainability in Colorado's Grand Junction area.

The feasibility study is driven by several key factors:

- *Economic Development:* SAF production presents an opportunity to expand capital investment, create local jobs, and diversify the regional economy.
- *Environmental Mandates and Voluntary Objectives:* Regulatory requirements and emission reduction goals at key airports in the Western Slope region (Aspen/Pitkin County, Rifle/Garfield, Grand Junction, and Eagle Regional Airports) necessitate sustainable fuel alternatives.
- *Infrastructure Utilization:* The analysis will examine how existing fuel supply chains can accommodate SAF transportation and blending facilities.
- *Feedstock Availability:* The study will evaluate local feedstocks such as forestry residues, agricultural waste, non-food energy crops, animal wastes and fats, used cooking oil, ethanol supply chains, municipal solid waste, and carbon dioxide (CO_2) point sources to determine the feasibility of producing SAF using technological pathways such as hydrotreated esters and fatty acids (HEFA), alcohol-to-jet (AtJ), gasification/Fischer-Tropsch (FT), pyrolysis, and power-to-liquid technologies (PtL).

By conducting a rigorous feedstock availability analysis, this task will provide a data-driven foundation for assessing SAF feasibility in Pitkin County and the broader Western Slope region. The outcomes of Task 1 will be critical in determining the project's viability and guiding future efforts toward sustainable aviation fuel production.

1.1 Objective

The objective of Task 1 is to evaluate and quantify the availability of sustainable feedstocks for SAF production within Western Colorado's Western Slope region. This assessment will identify viable feedstock sources, analyze their production potential, and determine their suitability for SAF conversion considering production and supply chain maturity. By examining factors such as regional availability, lifecycle emissions, and compliance with sustainability standards from the International Civil Aviation Organization (ICAO), the study will establish a Feedstock Feasibility Matrix to summarize the most promising options. The findings will provide critical data to support Pitkin County's decision-making on SAF implementation and guide further project phases.

1.2 Statement and Detailed Approach to Service:

The scope of this work involves identifying, analyzing, and evaluating various feedstocks that could contribute to SAF production.

The study will encompass different feedstock categories as illustrated tin the following table:

Table 1 – Feedstock Categories for SAF processing

Classification	Feedstock examples
Waste and Residue Lipids	- Used cooking oil (UCO) - Animal fats (tallow)
Sustainably Certified Energy Crops	- Camelina - Carinata - Switchgrass - Miscanthus
Agricultural Residues	- Corn stover - Wheat straw
Forestry Residues	- Logging residues (e.g., treetops, branches) - Sawdust and wood shavings - Wood-processing waste
Municipal Solid Waste (MSW)	- Organic fraction of municipal waste - Landfill gas
Industrial Gases	- Point source and waste carbon monoxide (CO) and carbon dioxide (CO_2) from industrial processes
Other	- Existing ethanol production or supply chains for ethanol

To ensure a thorough understanding of feedstock potential, the study will involve direct engagement with key stakeholders such as agricultural producers, academia, cooperatives, social society representatives, industry, airports, government authorities, aviation service and fuel suppliers, and local authorities. Through this collaboration, local conditions, production trends, and expansion opportunities will be assessed in detail.

The analysis will include both quantitative and qualitative aspects. The availability of each feedstock will be measured in terms of production volumes, historical trends, and geographical distribution. Additionally, sustainability considerations will be examined, associated with feedstock selected using as a basis the sustainability themes and related principles and criteria compliant with ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) Sustainable Aviation Fuels requirements, as follows:

1. Greenhouse Gases (GHG)
2. Carbon stock
3. Greenhouse gas Emissions Reduction Permanence
4. Water
5. Soil
6. Air
7. Conservation
8. Waste and Chemicals
9. Seismic and Vibrational Impacts

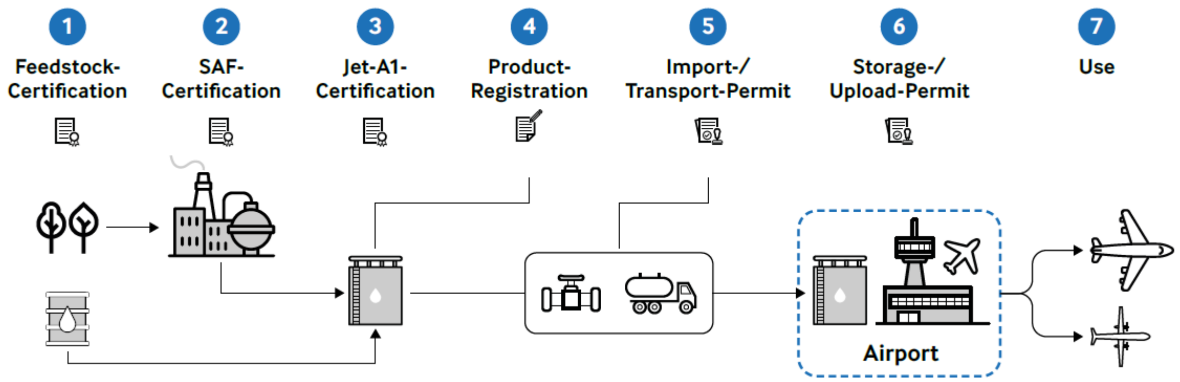
10. Human and labor rights
11. Land use rights and land use
12. Water use rights
13. Local and social development
14. Food security

The above evaluation shall provide a readiness analysis of pathways for sustainability certification, including eligibility under CORSIA (e.g. RSB CORSIA, ISCC CORSIA) and other schemes.

Specifically, the methodology and calculation of the default core life cycle GHG emissions of the different SAF pathways available under the CORSIA supporting document — Life cycle assessment methodology is used to ascertain the sustainability profile of selected feedstocks. This is the same LCA that can be used to reduce aircraft operators' offsetting obligations under CORSIA.

Similarly, it shall map sustainability certification steps along the production and supply chain and explain how the priority pathways can be used to streamline the sustainability certification process to further promote the use of SAF (figure 1). A discussion is included on the potential benefits and challenges of using the defined priority pathways for the sustainability certification and the implications for the development and implementation of SAF in the County's aviation industry.

Figure 1 – Simulation of SAF's sustainability certification pathway

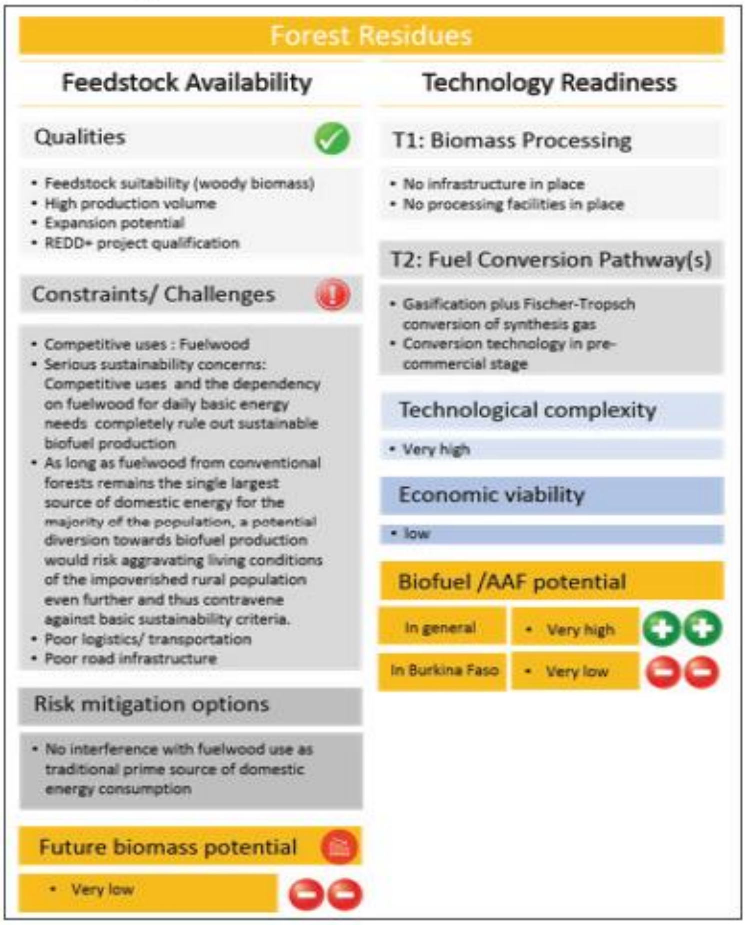


Ultimately, the work conducted under Task 1 will summarize the opportunities and constraints of the selected feedstocks and provide Pitkin authorities and relevant stakeholders with a visual representation of the feedstocks most viable for SAF production.

1.3 Deliverables

The outcomes of this task will be presented as a comprehensive narrative report. This report will include detailed insights into the availability and potential of SAF feedstocks, quantitative analysis with clarified assumptions. A graphical summary will be provided in the form of a 'Feasibility Matrix' which shall summarize the information obtained in the previous sections. The matrix will illustrate opportunities and major constraints with regard to the maturity of each feedstock's supply chain, as well as the feasibility of the entire supply chain (e.g. spatial quantification of feedstock densities for qualifying feedstock like forest residues), including available technology options, exemplified in the following figure:

Figure 2 - Simulation of a Feasibility Matrix for Forest Residues



A sustainability certification readiness analysis will also be included, outlining compliance pathways with ICAO's CORSIA standards and other relevant certification schemes.

A stakeholder engagement summary will be provided, documenting feedback from local agricultural and industrial representatives. This will ensure that the final recommendations align with regional realities and priorities.

1.4 Workplan – General Overview

The project is organized into a series of well-defined phases to ensure a structured approach to feedstock analysis, with each phase building upon the previous to create a cohesive workflow.

Phase I - Project Initiation

During the Project Initiation Phase, the work plan is finalized, and a kickoff meeting is conducted with the Pitkin team to establish methodologies, identify relevant stakeholders, and ensure alignment with project objectives and expectations.

- **MS01** - D1. Workplan and KoM w/ Pitkin team
- **MS02** - Identification of relevant stakeholders

Phase II - Stakeholder Engagement and Initial Assessment

During this phase, remote consultations are conducted with identified stakeholders such as agricultural producers, academia, industrial representatives, and regional authorities among others. These initial discussions serve to establish relationships, introduce the project, and gather preliminary insights into feedstock availability and sustainability. Savia Consulting will request the assistance of the Pitkin team in establishing the first line of connection with relevant stakeholders to ensure their trust and enhance cooperation. All communications thereon will be handled directly by Savia Consulting.

- **MS03** - Conduct kick-off remote meetings with identified collaborators
- **MS04** - Secondary data collection and feedstock assessment.
- **MS05** - D2. Presentation of First Draft consolidating preliminary findings.

Following is a preliminary list of stakeholders which will be extended as the consultation process progresses:

Table 2 - Preliminary list of relevant stakeholders

Entity	Contact	e-mail
Pitking County		
Pitkin County Administration	Rich Englehart	rich.englehart@pitkincounty.com
Pitkin County Administration	Michael Port	michael.port@pitkincounty.com
Atlantic Aviation	Jonathan Jones	Jonathan.Jones@atlanticaviation.com
Aspen/Pitkin County Airport	Diane Jackson	diane.jackson@aspenairport.com
Pitkin County Landfill	Brian Pettet	brian.pettet@pitkincounty.com
Mesa County		
Mesa County Administration	Todd Hollenbeck	todd.hollenbeck@mesacounty.us
Grand Junction Economic Partnership	Curtis Englehart	curtis@gjep.org
Grand Junction Regional Airport	Angela Padalecki	apadalecki@gjairport.com
Mesa County Landfill	Jennifer Richardson	jennifer.richardson@mesacounty.us
CSU Fruita Research Station	Dr Harry Cabot	perry.cabot@colostate.edu
Mesa County Emergency Management: Wildfire Mitigation	Andrew Martsolf	andrew.martsolf@mesacounty.us
Persigo Wastewater Treatment	Randi M. Kim, P.E.	randik@gjcity.org
CSU Tri River Extension: Agricultural & Livestock Resources	Douglas Dean	doug.dean@mesacounty.us
Eagle County		
Delta County Administration	Jeff Schroll	jeff.schroll@eaglecounty.us
Eagle County Regional Airport	David Reid	david.reid@eaglecounty.us
Eagle County Landfill	Jesse Masten	landfill@eaglecounty.us
Delta County		
One Delta County	Greg Pope	gpope@deltacounty.com
Delta County Administration	Robbie LeValley	rlevalley@deltacountyco.gov
Public Works- Delta County	Scott Sheetz	scotts@deltacountyco.gov
Delta County Landfill and North Fork Transfer Station	Gary Bardessona	gbardessona@deltacountyco.gov
Delta County Emergency Management	Kris Stewart	kstewart@deltacountyco.gov
Wastewater Treatment - City of Delta	Andy Mitchell	andy@cityofdelta.net
Town of Hotchkiss Public Works Department	Mike Owens	hpwd@townofhotchkiss.com
Town of Crawford	Bruce Bair	crawfordpublicworks@gmail.com
Town of Paonia	Cory Heiniger	coryheiniger_pw@townofpaonia.com
Town of Cedaredge	Carl Holm	cholm@cedaredgecolorado.com
CSU Tri River Extension (Delta Office)	Jackie Shea	jackie.shea@coloradostate.edu
Sawdust & Wood Shavings - Redemption Mill	Austin Chalfant	office@redemptionmill.us

Phase III - Data Collection and Feedstock Assessment

The Data Collection and Feedstock Assessment marks a critical stage in the project. Quantitative and qualitative data are collected, focusing on feedstock volumes, geographical distribution, sustainability considerations, and potential for expansion. This stage lays the groundwork for deeper analysis while also preparing for direct engagement during the on-site visit.

An on-site visit is conducted as part of the data collection process, adding depth and validation to the assessment. During this visit, the team engages directly with stakeholders through in-person meetings, site inspections, and collaborative discussions. Facilities and sites relevant to feedstock production and supply chains are examined to assess infrastructure capabilities. Local trends and opportunities are contextualized through consultations with regional experts, ensuring the analysis is grounded in practical, region-specific realities.

Subsequent to on-site visits, the project transitions into the evaluation of conversion pathways and feasibility analysis. Here, the suitability of identified feedstocks for SAF production is evaluated, and a feasibility matrix is developed to synthesize findings. The analysis culminates in the first draft of the final report, where preliminary results are consolidated and reviewed by Pitkin Partners.

- **MS06** - Gathering data and consultation process through in person meetings with selected key stakeholders.
- **MS07** - Completion of the conversion pathways and feasibility analysis in correlation with selected feedstocks, including the development of a feasibility matrix for SAF feedstock evaluation.
- **MS08** - D4. Delivery of the first draft of the final report, consolidating findings for review and refinement.
- **MS09** - Revision period – Pitkin Team

Phase IV – Delivery of the Final Report and Presentation

The project concludes with the **Delivery of the Final Report and Presentation**, encapsulating all findings and providing strategic recommendations to guide further actions.

- **MS10** - D5. Delivery of the final report and presentation, summarizing key findings and providing strategic recommendations.

The following table summarizes the milestones:

Table 3 - Table of Milestones

MS#	Description	Due	Proof of Completion
Phase I - Project Initiation			
MS01	D1. Workplan and KoM w/ Pitkin team	4 April	Document delivery
MS02	Identification of relevant stakeholders	4 April	Delivery of list
Phase II - Stakeholder Engagement and Initial Assessment			
MS03	Conduct kick-off remote meetings with identified collaborators	7 – 30 April	Progress report
MS04	Secondary data collection and feedstock assessment.	7 April - 30 May	
MS05	D2. Presentation of First Draft consolidating preliminary findings.	28 April	Document delivery
Phase III - Data Collection and Feedstock Assessment			
MS06	Gathering data and consultation process through in person meetings with selected key stakeholders.	1-16 May	
MS07	Completion of the conversion pathways and feasibility analysis in correlation with selected feedstocks, including the development of a feasibility matrix for SAF feedstock evaluation.	23 May	
MS08	D4. Delivery of the first draft of the final report, consolidating findings for review and refinement.	05 June	Document delivery
MS09	Revision period – Pitkin Team	06 - 13 June	Revised document delivery
Phase IV - Delivery of the Final Report and Presentation			
MS10	D5. Delivery of the final report and presentation, summarizing key findings and providing strategic recommendations.	20 June	Document delivery

2. Introduction

Sustainable Aviation Fuel production offers a timely and compelling economic development opportunity for Western Colorado, with the potential to create jobs across agriculture, forestry, waste management, transportation, and fuel processing. It also offers a pathway to fill employment gaps left by the declining coal, oil, and gas industries, ensuring a transition to a more sustainable and diversified economy.

Government authorities and regional stakeholders are wise to embrace this opportunity, recognizing that sourcing complementary feedstocks externally does not undermine the feasibility for SAF development and deployment. Instead, it strengthens industry collaboration, paving the way for a thriving SAF ecosystem that supports local economies while advancing national and global decarbonization goals.

The successful development of SAF production systems hinges on the availability, accessibility, and sustainability of appropriate feedstocks. In Western Colorado, a diverse landscape of agricultural, forestry, municipal, and industrial resources presents promising opportunities to support SAF initiatives. However, these must be carefully assessed against a backdrop of local production practices, infrastructure capabilities, regulatory frameworks, and market dynamics.

By leveraging locally available feedstocks and complementing them with resources from neighboring states, Western Colorado can establish itself as a critical player in SAF supply chains, ensuring a resilient, diversified fuel strategy. *While no single feedstock is available in sufficient volume to support a standalone SAF refinery*, this does not diminish regional feasibility—rather, it strengthens opportunities for strategic collaboration and investment.

This study evaluates a range of potential SAF feedstocks, including agricultural products such as camelina, soybean, and canola, as well as wastes and residues like used cooking oil, animal fats, forestry residues, municipal solid waste, and industrial gases. Particular attention is given to the sustainability characteristics in alignment with CORSIA's International Aviation Sustainable Aviation Fuels requirements, regional production potential, and suitability for SAF conversion technologies such as HEFA, FT, AtJ, pyrolysis, and PtL, considering their respective maturity levels.

Community engagement revealed strong support for SAF development. Farmers welcomed camelina for its low water use and equipment compatibility. Forestry and land management stakeholders backed residue repurposing, and waste officials acknowledged the promise of MSW—provided infrastructure and sorting systems are improved

The objective of this report is to establish a detailed understanding of the feedstock landscape within the Western Slope region, providing a foundation upon which subsequent phases of the SAF feasibility study will build. In doing so, it aims to illuminate both the opportunities and the constraints inherent in leveraging local resources for SAF production.

3. Existing and Potential Feedstocks

Sustainable aviation fuel production depends on a variety of feedstocks, each of which must meet sustainability criteria and be economically and logistically viable. In the Western Slope region of Colorado, a range of feedstock options are available, each with unique properties and challenges.

The following section describes potential feedstocks available for SAF processing within Colorado's Western Slope. To ensure sufficient volume for a SAF refinery, feedstocks from Eastern and Central Colorado, as well as neighboring states, are also considered. Additionally, the aggregation of similar feedstocks is evaluated, taking into account both the opportunities and challenges associated with centralizing supply and the heterogeneous nature of the resulting feedstock mix.

3.1 Used cooking oil - Overview

Used cooking oil (UCO) is a widely utilized feedstock for SAF production via the HEFA pathway. As a post-consumer waste product, UCO is considered environmentally advantageous and is already well integrated into Colorado's renewable fuel landscape.

In Western Colorado, UCO is sourced from a variety of food service establishments including high-volume restaurants like Bin 707 Foodbar and The Pullman in Grand Junction, as well as hotels such as Hotel Maverick and Strater Hotel in Durango. Institutional kitchens, including those at Colorado Mesa University and other educational institutions across the Western Slope, also contribute to regional UCO recovery through cafeteria operations.

Beyond the hospitality sector, larger-scale food processors like Rocky Mountain Natural Meats in Denver generate substantial volumes of UCO, complementing the contributions from institutional and commercial kitchens, including those at Colorado Mesa University in Grand Junction. Estimates suggest that Western Colorado generates between 5 and 10 million gallons of UCO annually, according to collection data from service providers such as Aspen Oil Recycling and Titan Grease Service.

These companies play a vital role in aggregating UCO from distributed sources and refining it for downstream markets. While a 2025 stakeholder conversation with Titan Grease indicated that their current collection volumes are committed to stable offtake markets, this position reflects the strength of existing demand rather than a lack of potential for future SAF partnerships. Indeed, Titan and other collectors help ensure a well-established logistics infrastructure, which could be leveraged if SAF producers offer competitive and consistent procurement terms.

At present, the most significant barrier to redirecting UCO into SAF pathways is not collection capability, but the presence of well-developed competing markets. UCO is already widely used for biodiesel production, with companies like GRNS Energy (Grand Junction) and Rocky Mountain Biodiesel (Montrose) relying on it as a core input. Additionally, rendering firms such as

SUSTAINABLE AVIATION

Darling Ingredients and JBS USA process certain grades of UCO into animal feed additives, ensuring full utilization of available material across industrial sectors.

Given the strength of these established applications and the economic stability they provide, current UCO streams are predominantly directed toward biodiesel production and animal feed markets. While SAF represents a compelling future use case, realizing this potential may require either market realignment or policy-driven incentives to shift supply chains in that direction.

3.1.1 Sustainability Analysis

UCO is recognized internationally as a highly sustainable feedstock due to the following factors:

- **Lifecycle GHG Emissions:** UCO-based SAF can reduce lifecycle emissions by up to 85% relative to fossil jet fuel (ICAO, 2023).
- **Low ILUC Risk:** As a post-consumer waste product, UCO does not drive land use change or compete with food systems.
- **Water and Soil Impacts:** Minimal, as UCO is not cultivated but collected post-use.
- **Regulatory Compatibility:** UCO meets core eligibility criteria under ICAO CORSIA, ISCC, and RSB frameworks, allowing producers to access international SAF credits and incentives.

The default core LCA results for the carinata HEFA pathway is 13.9 g CO_2e/MJ. The following table shows the parameters for LCA values for the UCO HEFA pathway:

Table 4 - LCA results for UCO HEFA pathway [gCO2e/MJ]

Feedstock	Data Provider	Model	Feedstock cultivation and collection	Feedstock Transportation	Feedstock-to Fuel Conversion	Fuel Transportation	Total	Midpoint value
UCO	MIT	GREET	3.6	0.3	10.5	0.5	**14.8**	**13.9**
	JRC	E3	0	1.7	11	0.3	**13**	

Source: CORSIA supporting document — Life cycle assessment methodology

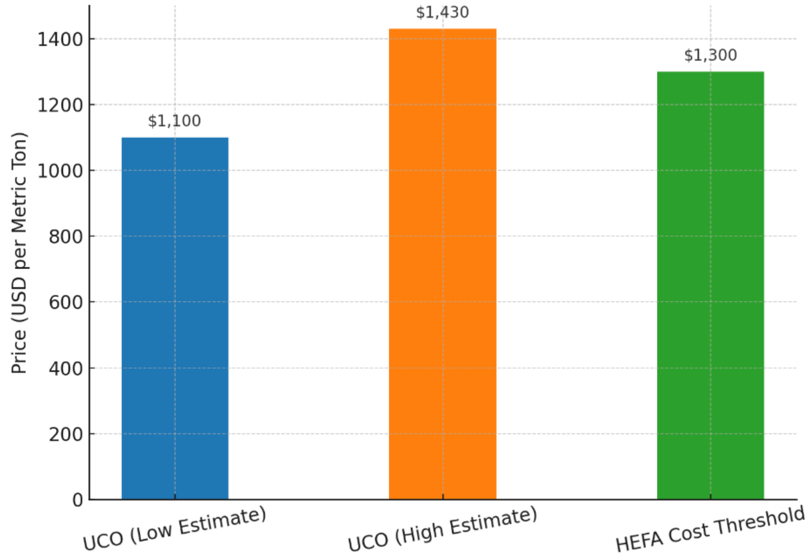
3.1.2 Feedstock Analysis

Nationally, the U.S. generates an estimated 6.5 billion pounds (2.93 million metric tons) of UCO annually (NREL, 2022). In Colorado, the recoverable fraction is far lower. Based on food service density and population ratios, estimates suggest 58,600 metric tons per year of UCO could be sourced statewide, with Western Colorado contributing a modest share of approximately 20% or 11,720 metric tons per year.

At the current estimated production, even if all Colorado UCO were redirected to SAF, it would account for only 1.2% of the UCO needed for one commercial HEFA refinery, which requires 934,940 metric tons annually.

Affordability is another barrier. UCO currently trades for $0.50–$0.65/lb ($1,100–$1,430/MT) on global spot markets (Jacobsen, 2024). This is within economic range for SAF, but tightening supply and competition from biodiesel refiners (especially in California under LCFS) have made the market volatile. Moreover, Titan Grease confirmed they have stable offtake partners and do not plan to reallocate volumes toward SAF production under current conditions.

Figure 3 - UCO Prices vs. HEFA Feedstock Cost Threshold



Source: Savia Consulting

3.1.3 Opportunities and Considerations

Opportunities:

- UCO is an established, sustainable HEFA feedstock.
- Urban collection networks already exist (e.g., Titan Grease Service).
- Meets criteria for major SAF crediting schemes (LCFS, CORSIA, IRA 40B).

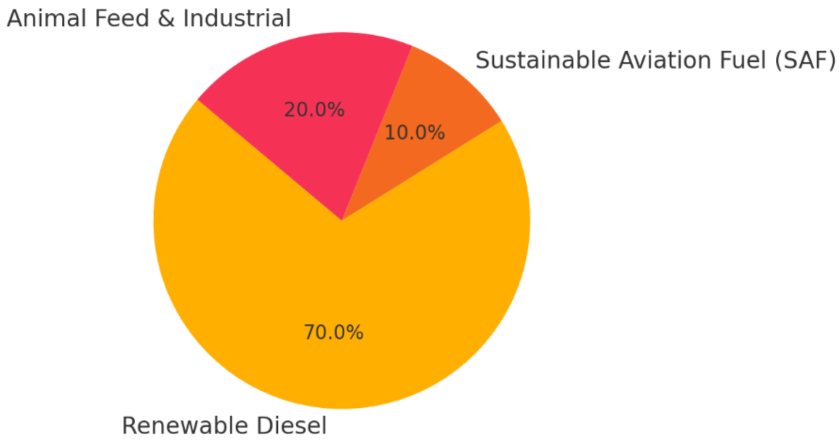
Considerations:

- Total statewide UCO availability represents less than 3% of HEFA refinery needs.
- Western Colorado's rural profile limits collection density.
- Strong market competition from renewable diesel producers reduces available supply.
- Some collectors (e.g., Titan Grease Service) currently allocate UCO to existing biodiesel or feed markets under stable contracts, limiting near-term diversion potential.

3.1.4 Conclusion and Key Findings

Used cooking oil is a technically viable and highly sustainable feedstock for SAF production, offering excellent carbon intensity profiles and regulatory compliance. However, Colorado's available UCO volumes are modest, and competition from more mature markets (e.g., bio-diesel and renewable diesel) reduces the likelihood of reallocating this feedstock toward SAF.

Figure 4 - Estimated U.S. UCO Allocation by Sector



Source: Savia Consulting from Clean Fuels Alliance America. (2023) and NRL (2023)

Even at full statewide recovery, Colorado could meet only ~2% of a HEFA refinery's annual feedstock requirement. While UCO should remain part of a diversified SAF feedstock strategy, its role in Western Colorado will be minor unless large-scale collection expansion or policy intervention shifts the current supply paradigm.

3.2 Animal fats - Overview

Animal fats, including tallow derived from meat processing operations, represent a technically viable feedstock for SAF production via the HEFA pathway. In Western Colorado, several small-to mid-scale meat processors, such as Sunnyside Meats in Durango and Mountain Meat Packing in Craig, support regional meat supply chains and contribute to the pool of renderable animal byproducts. Further east, larger operators like JBS and Colorado Premium, both based in Greeley, operate facilities with rendering capabilities that serve national distribution networks.

Across the counties of Montrose, Delta, Mesa, and Garfield, approximately 250 ranches raise between 150–300 head of cattle each, resulting in an estimated 50,000–75,000 head of cattle annually (USDA Census of Agriculture). Based on industry averages, tallow rendering yields range from 10–15% of live weight in lean-meat systems like Colorado's Western Slope, compared to 30–40% in feedlot-dense regions like Nebraska, Texas, or Kansas (National Renderers Association). This lower recovery rate significantly constrains feedstock output potential.

Existing collection services play a crucial role in ensuring the efficient processing and distribution of these fats. Similarly to that described above on collection services for UCO, Darling Ingredients also specializes in the collection of animal byproducts, including tallow, and refining them into usable materials for biofuel production. Additionally, JBS manages rendering plants that recover tallow and other fats for industrial applications. These services provide the logistical framework necessary to collect and process animal fats systematically, enhancing their viability as a SAF feedstock.

3.2.1 Sustainability Analysis

Animal fats are considered among the most sustainable SAF feedstocks under the ICAO CORSIA and RSB frameworks. Their use typically results in:

- **Lifecycle GHG reductions** exceeding 80% compared to fossil jet fuel;
- **Low ILUC (Indirect Land Use Change) risk**, since fats are co-products of meat production and not grown for fuel purposes;
- **Minimal additional environmental burdens** (e.g., water, fertilizer) beyond existing livestock operations;
- **Compatibility with waste valorization goals**, which aligns with state-level circular economy and decarbonization strategies.

Moreover, animal fats meet the regulatory requirements of major sustainability certification bodies (ISCC, RSB), supporting downstream compliance with LCFS, IRA, and 40B programs.

The default core LCA results for the tallow HEFA pathway fall within a range of 378.6 to 22.5 g CO_2e/MJ. This wide range is because when tallow is treated as a waste or by-product of beef production, the system boundary for the LCA begins at the rendering stage. In contrast, if tallow is classified as a co-product, the LCA must include upstream processes such as cattle rearing and slaughter. The table below presents the total GHG emissions associated with SAF produced from tallow via the HEFA pathway under both system boundary scenarios. The Committee on Aviation Environmental Protection (CAEP) has determined that tallow should be considered a by-product, meaning the default midpoint LCA values are calculated based on a system boundary that starts at the rendering phase. The following table shows the parameters considered for the LCA tallow HEFA pathway:

Figure 5 - LCA results for tallow HEFA pathways [gCO2e/MJ]

Feedstock	Data provider	Model	Feedstock cultivation and collection	Feedstock transportation	Feedstock-to fuel conversion	Fuel transportation	Total	Midpoint value
Tallow (starts at tallow rendering)	MIT	GREET	13.9	0.5	10.5	0.5	**25.3**	**22.5**
	JRC	E3	9.9	0.4	9.3	0.3	**19.8**	
Tallow (starts at cattle growth)	MIT	GREET	310.5	0.4	9.4	0.6	**320.9**	**n/a**
	ANL	GREET	368.3	0.4	9.4	0.6	**378.6**	

Source: CORSIA supporting document — Life cycle assessment methodology

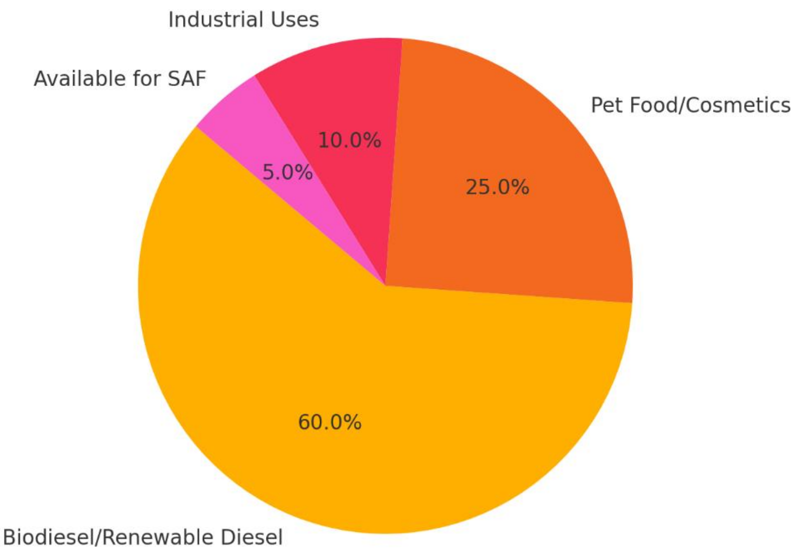
3.2.2 Feedstock Analysis

The Western Slope's rendering potential, while real, is highly constrained by volume and cost. Using conservative recovery assumptions (10–15% of live weight), the region could yield 15–20 million gallons of animal fats per year (National Renderers Association). Converting this to metric tons, assuming a density of 0.89 kg/L, results in approximately 50,400–67,200 metric tons annually.

In contrast, a single commercial HEFA facility requires 934,940 metric tons of lipid feedstock per year. This places Western Colorado's tallow contribution at only 5.3–7.1% of the required input—under the optimistic assumption that all renderable fats are diverted exclusively for fuel, which is economically improbable.

Additionally, national context reveals that the U.S. produces approximately 1.8 million metric tons of inedible tallow annually (USDA ERS, 2022), but most of it is already claimed by existing markets, including biodiesel, pet food, and cosmetics, as shown in the following figure:

Figure 6 - Current Uses of U.S. Rendered Tallow



Source: Savia Consulting

Western Colorado's share, due to leaner livestock systems and smaller-scale operations, is a minor fraction of the national total. The following table illustrates a comparison between the Western Slope and National volumes:

Table 5 - Regional vs. National tallow recovery potential

Region	Est. Annual Tallow (MT)	% of HEFA Refinery Input	Recovery Rate	Notes
Western Colorado (lean cattle)	50,400–67,200	5.5–7.3%	10–15%	Based on 50,000–75,000 head of cattle
Feedlot Regions (e.g., TX, NE)	150,000–250,000	16–27%	30–40%	High-yielding, centralized operations
U.S. National Total	~1,800,000	~200% (2x refinery need)	Variable	Majority already allocated

Source: Savia Consulting

3.2.3 Opportunities and Considerations

Opportunities:

- Tallow is an approved HEFA feedstock with proven commercial viability.
- It fulfills CORSIA and RSB sustainability requirements.
- Collection logistics (e.g., Darling Ingredients, JBS rendering plants) already exist in the state, enabling streamlined supply chains for industrial uses.
- Small, blended use of animal fats vegetable oils, and UCO in a broader SAF strategy may be possible.

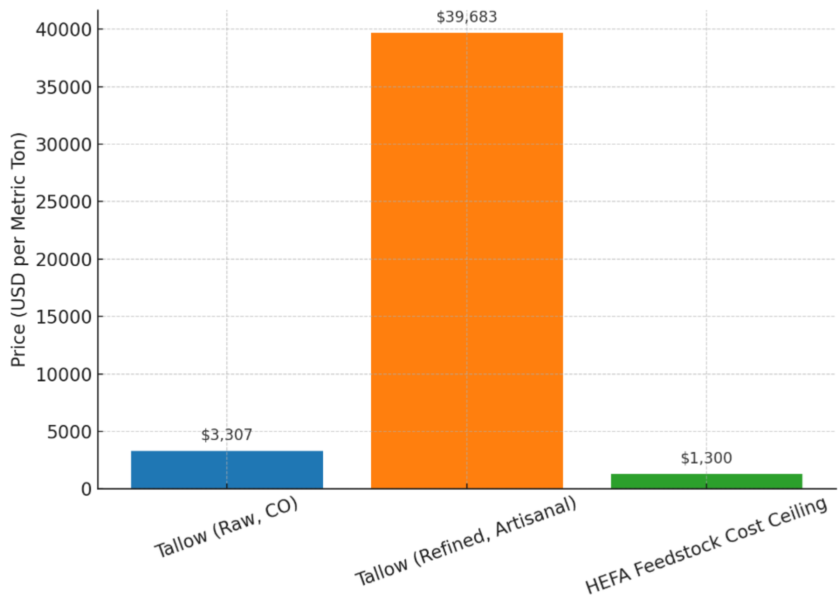
Considerations:

- Premium markets offer significantly higher margins than SAF producers can match.
- Renderable fat yields in Western Colorado are lower than national feedlot averages.
- Regional supply represents less than 10% of the feedstock needed for a single HEFA refinery.
- Without policy incentives or new rendering infrastructure, tallow remains economically unattractive for SAF use in the Western Slope.

3.2.4 Conclusion and Key Findings

Animal fats, particularly tallow, are technically sound and sustainability-compliant feedstocks for SAF production. However, in Western Colorado, their economic and volumetric constraints severely limit their feasibility as a core input. Even under optimistic recovery assumptions, the region can only meet 5–7% of a HEFA refinery's feedstock needs. Current raw material pricing at $1.50/lb, driven by new high-value markets, places tallow well above the cost thresholds for SAF viability, as illustrated in the following figure:

Figure 7 - Tallow Market Prices vs. SAF Feedstock Affordability



Source: Savia Consulting

While animal fats may have a minor, blended role in a diversified SAF supply chain, they should not be considered a primary solution for Western Colorado's SAF ambitions. Future shifts in regulatory policy, pricing dynamics, or regional rendering capacity could merit a re-evaluation of their role.

3.3 Camelina - Overview

Camelina (Camelina sativa), a member of the Brassicaceae family, is a hardy, fast-growing oilseed crop recognized for its low input requirements and potential to serve as a feedstock for SAF via HEFA pathways. Classified as a "sustainably certified energy crop," camelina is notable for its compatibility with existing agricultural rotations, particularly as a cover crop or winter crop substitute.

For this feasibility study, camelina was considered as a replacement for winter wheat acreage in six counties across Western Colorado's Western Slope: Delta, Mesa, Garfield, Montrose, Eagle, and Pitkin. These counties represent an agroecological zone with suitable climate, infrastructure, and arable land already used for similar dryland winter crops, like winter wheat, making the region a potentially viable producer of camelina feedstock for SAF production.

This section integrates both primary and secondary data. Primary findings were gathered through structured conversations with local farmers, CSU Extension offices, and agricultural researchers across Colorado. A workshop was held in Delta Couty with local farmers and one-on-one in-person meetings convened with additional farmers and agriculture and food systems experts across the wider Western Slope. Where direct engagement was not feasible—particularly in less-populated central counties—estimates were drawn from publicly available secondary data, including the USDA's Cropland Data Layer (CDL) and 2022 Census of Agriculture. Distinctions between these data sources are noted throughout.

3.3.1 Sustainability Analysis

Camelina ranks favorably on nearly all ICAO CORSIA sustainability themes:

- **GHG Reduction:** Camelina-based HEFA SAF has shown lifecycle GHG emission reductions exceeding 60%.
- **Land Use and Food Security:** Camelina does not displace food crops when cultivated on existing wheat lands.
- **Water and Soil Impact:** As a drought-tolerant crop, camelina has low irrigation needs.
- **Certification Readiness:** Camelina has been approved under several sustainability certification systems, including RSB and ISCC.

The default core LCA results for the camelina HEFA pathway fall within a range of 39.9 to 44.1 g CO_2e/MJ, with the final default core LCA value set at 42.0 g CO_2e/MJ. The following table illustrates the parameters considered and how the LCA for the US compares to other regions:

Table 6 - LCA results for camelina HEFA [gCO2e /MJ]

Feedstock	Data source	Model	Cultivation	Feedstock transportation	Oil extraction	Oil transportation	Feedstock to fuel conversion	Fuel transportation	Total	Midpoint value
Camelina	US	GREET	23	0.9	2.9	0.5	14	0.5	**41.8**	**42.0**
	Canada	GREET	26.3	0.9	2.7	0.5	13.3	0.5	**44.1**	
	EU (JRC)	GREET	19.4	0.8	4.6	0.5	14.1	0.5	**39.9**	
	EU (JRC)	E3db	25	0	4.8	0.2	11	0.3	**41.3**	

Source: CORSIA supporting document — Life cycle assessment methodology

3.3.2 Feedstock Analysis

Camelina can thrive on marginal land with relatively low water and fertilizer inputs, which is ideal for Western Colorado's semi-arid climate and water-constrained agricultural systems. Based on a conservative conversion factor of 1 metric ton of camelina oil per 2.47105 acres, we estimated production potential by analyzing existing winter wheat cultivation data from USDA's CDL and local agricultural extension sources for the six focus counties.

Table 7 - Camelina production potential in the Western Slope, CO

County	Estimated Winter Wheat Acreage	Estimated Camelina Oil Yield (metric tons)
Delta	3,100 acres	1,254
Mesa	2,500 acres	1,012
Garfield	1,800 acres	728
Montrose	2,900 acres	1,173
Eagle	1,200 acres	486
Pitkin	300 acres	121
Total	**11,800 acres**	**4,774**

These estimates are conservative, excluding uncultivated or fallow lands that might support camelina through targeted agronomic adaptation or subsidy-supported crop switching. To ground this analysis in realistic adoption scenarios, the evaluation focused on land currently planted with winter wheat.

Winter wheat acreage was chosen as the benchmark for estimating camelina production potential due to the strong agronomic and seasonal compatibility between the two crops. Both are planted in the fall and harvested by early summer, enabling a seamless crop substitution without disrupting established planting schedules or displacing higher-value summer crops such as sweet corn or alfalfa. This consideration is essential, as camelina must not compete with food production. In particular, alfalfa—a semi-perennial forage crop lasting up to four years—plays a vital role in regional livestock systems and generates greater economic returns than camelina under current market conditions. Replacing alfalfa with camelina would limit planting frequency and undermine the crop's feasibility. Therefore, focusing on winter wheat acreage provides a realistic and responsible pathway to integrating camelina into existing agricultural systems while preserving both food security and farmer income.

Building on this rationale, the region's access to land grant university Extension services and Agricultural Experiment Station research facilities—such as those provided by the CSU Tri-River Area Extension and 4 AES research centers on the Western Slope—offers crucial support for farmer education, technical training, and transition readiness as well as potential pre-implementation research projects. These local institutions enhance the viability of introducing camelina by reducing adoption risks and facilitating the necessary agronomic adjustments for successful crop integration.

While the Western Slope offers a promising entry point for camelina cultivation, the estimated oil output falls significantly short of meeting the full capacity needs of a commercial HEFA refinery. Specifically, to operate at full capacity, a HEFA facility requires approximately 934,940 metric tons of oil-based feedstock annually. This far exceeds the projected camelina oil volumes from the six-county focus area. As a result, it becomes necessary to evaluate broader production potential across other regions of Colorado to assess whether combined outputs could support a viable SAF supply chain.

3.3.3 Expanded Regional Potential for Camelina Production

In 2013–2014 dryland trials at CSU's Southwestern Colorado Research Center, winter camelina demonstrated potential as an oilseed crop suited to semi-arid conditions. The crop showed reliable overwinter survival and minimal pest or disease pressure. Germination and blooming were not always consistent and timely yet its short growing season and compatibility with regional crop rotations make camelina a suitable crop to adopt in water-limited systems.

The CSU Extension Administrative Office's 2011 trials on producing dryland camelina in eastern Colorado showed that the crop is generally well-suited to the region's dryland farming systems, offering an attractive alternative to traditional fallow and fitting well as a cover crop with existing agricultural production. The crop demonstrated strong adaptability to local conditions, including drought tolerance and low input requirements, and could be managed with standard farming equipment. However, the trials also revealed challenges, particularly in achieving consistent stand establishment and managing herbicide sensitivity, which require careful planning.

To further assess the potential of camelina as a sustainable feedstock for SAF within the needed volumes, this section expands the analysis beyond the Western Slope counties to include Central and Eastern Colorado. The goal is to determine potential camelina oil production by examining currently cultivated winter wheat acreage, using the same conservative yield estimate of 1 metric ton of camelina oil per 2.47105 acres.

Table 8 - Western Slope - potential camelina oil production

County	Winter Wheat Acreage	Estimated Camelina Oil Yield (MT)
Delta	3,100	1,255
Mesa	2,500	1,012
Garfield	1,800	728
Montrose	2,900	1,174
Eagle	1,200	486
Pitkin	300	121
Sub-total	*11,800*	*4,776*

Table 9 - Central Colorado - potential camelina oil production

County	Winter Wheat Acreage	Estimated Camelina Oil Yield (MT)
Chaffee	400	162
Fremont	600	243
Park	500	202
Lake	300	121
Summit	150	61
Sub-total	*1,950*	*789*

Table 10 - Eastern Colorado - potential camelina oil production

County	Winter Wheat Acreage	Estimated Camelina Oil Yield (MT)
Kit Carson	65,600	26,547
Yuma	93,600	37,879
Washington	78,600	31,808
Lincoln	28,700	11,614
Logan	128,941	52,181
Weld	93,343	37,775
Prowers	79,700	32,253
Phillips	95,730	38,741
Sedgwick	81,240	32,877
Sub-total	*745,454*	*301,675*

Table 11 - Colorado Statewide - potential camelina oil production

Region	Winter Wheat Acreage	Estimated Camelina Oil Yield (MT)
Western	11,800	4,776
Central	1,950	789
Eastern	745,454	301,675
Total	**759,204**	**307,240**

The analysis indicates potential for camelina oil production across Colorado, offering a strong foundation for regional SAF supply chain development. With an estimated annual production of approximately 307,240 metric tons—based on current winter wheat acreage—the Western Slope has the potential to supply over 32% of the camelina oil required to run a commercial-scale SAF refinery at full capacity (776,000 metric tons/year, ICAO RoT). Harnessing this potential presents a significant opportunity to spur economic growth, establish a robust regional supply chain, and position the area as a key contributor to the emerging sustainable aviation fuel market. Eastern counties such as Logan, Kit Carson, and Yuma stand out with high winter wheat acreages, making them prime candidates for large-scale camelina cultivation. Central Colorado offers smaller but important opportunities, and the Western Slope contributes a viable base for localized SAF production and economic growth. With coordinated planning, infrastructure investment, and multistate collaboration, Colorado can play a pivotal role in launching a scalable, regionally integrated SAF supply chain—driving both agricultural innovation and clean energy advancement.

3.3.4 Opportunities and Considerations

Camelina cultivation on the Western Slope presents a promising opportunity for sustainable agriculture and renewable fuel development in the Western Slope and across Colorado, supported by several key advantages:

- A short growing season and strong frost tolerance, making it well-suited for the region's climate

- Compatibility with existing alfalfa equipment, reducing barriers to entry for farmers
- Lower fertilizer and irrigation needs—roughly half that of winter wheat—offering environmental and cost benefits
- The ability to make productive use of fallow land through water conservation programs
- A foundation of local knowledge from experimental test plots
- Readily available, mature conversion technology for processing camelina oil into SAF

As momentum builds, thoughtful planning can help address a few strategic considerations:

- Market Development: As a relatively new crop, camelina will benefit from expanded market commitments and contract structures to reduce grower risk
- Processing Infrastructure: Investment in regional oil extraction and crushing facilities will be key to scaling production
- Farmer Engagement: Continued outreach, demonstration trials, and yield assurance programs can help boost farmer confidence and adoption

Scaling SAF production will also require:

- Establishment of local oilseed processing infrastructure
- Integration with existing aggregation hubs and development of efficient transportation logistics
- Robust farmer training and technical support focused on both oil and protein co-products
- Strategic public and private investment to build and strengthen early-stage supply chains

With coordinated efforts and the region's inherent advantages, camelina could play a pivotal role in advancing sustainable fuel and agricultural resilience on the Western Slope.

3.3.5 Conclusion and Key Findings

Based on interviews with CSU Extension agents and local growers in Delta, Mesa, and Montrose counties, camelina was identified as a regionally compatible crop with strong potential for rotational use on current winter wheat acreage. Local stakeholders confirmed both the agronomic viability of camelina and a growing interest in alternative oilseed markets, particularly those linked to low-carbon aviation fuels.

Furthermore, Outputs from the workshop held with local farmers in Delta County as well as from several interviews, telephone conversations, and email exchanges with additional farmers across the Western Slope show a willingness to take part in exploring the feasibility of camelina production. Considering they are provided with guidance and rewarded for all risks taken as well as paid fairly for the harvest, the opportunity to produce camelina for SAF purpose was welcomed.

Using these field insights and conservative yield assumptions (1 metric ton per 2.47105 acres), we estimate that the Western Slope counties could produce approximately 4,774 metric tons of camelina oil annually (assuming camelina replaces winter wheat production). Secondary data analysis, including USDA CDL and state-level crop statistics, expanded this estimate to include Central and Eastern Colorado—bringing the statewide total to approximately 307,204 metric tons per year if identified acreage is placed under production. The use of the rail system becomes crucial when shipping complementing feedstock volumes to the Western Slope to lower transport and logistics costs as well as maintain a more favorable carbon intensity score.

However, this figure represents just 32% of the annual feedstock requirement for a single commercial-scale HEFA refinery, which needs 934,940 metric tons of camelina oil to operate at full capacity. This production gap highlights a critical challenge: while Colorado can support a foundational camelina supply chain, it cannot do so at the scale required for standalone SAF operations without additional sourcing. This does not take away from the opportunity for the Western Slope to proceed with the development and deployment of a SAF supply chain. Agricultural jobs will be generated as well as the economic development resulting from the SAF value chain.

To address this shortfall, camelina oil must be imported from neighboring agricultural states with compatible climates and rail access—such as Kansas, Nebraska, North Dakota, and Montana. Below is an overview of each state's experience, potential acreage, and estimated oil yields based on conservative metrics:

Table 12 - - Camelina Cultivation Potential in Neighboring States

State	Camelina Experience	Potential Acreage	Estimated Camelina Oil Yield (MT)
Kansas	Ongoing research under non-irrigated conditions has shown camelina's adaptability.	Significant wheat-fallow systems present opportunities for camelina integration.	0.408
Nebraska	Research indicates camelina's potential in dryland cropping systems.	Wheat-fallow systems could be optimized by introducing camelina.	
North Dakota	Pilot programs have explored camelina's viability, with some challenges noted in winter survival.	Extensive wheat-fallow acreage offers potential for camelina cultivation.	
Montana	Established camelina production with favorable results; Sustainable Oils has been active in the region.	Significant wheat-fallow systems present opportunities for camelina integration.	

Source: (L.) Crantz, Alex Wittenberg, James V. Anderson, Marisol T. Berti, and Sustainable Oils

Leveraging the existing agricultural frameworks and ongoing research in these states could significantly contribute to the feedstock supply for SAF production for the successful deployment of a SAF refinery in the Western Slope. Alternatively, camelina oil may be supplemented with other oil-based approved SAF feedstocks under CORSIA eligible fuels (CEF) like soybean and canola oil, evaluated in the following section.

Beyond its value as an oilseed crop, camelina offers potential for additional economic returns through its protein-rich meal, a co-product of oil extraction. While not yet fully approved by the FDA for broad livestock feed applications, camelina meal shows promise as a nutritional supplement similar to soybean meal. Regulatory approval and commercial validation could enhance the crop's financial viability, improve grower incentives, and support regional circular bioeconomy goals.

Colorado is well-positioned within a Class I rail corridor served by BNSF and Union Pacific, offering a feasible logistics pathway to bring in feedstock for processing. However, realizing its full potential will require multistate coordination, targeted investment in critical infrastructure—such as oilseed crushing facilities and regional rail spurs—and sustained public-sector support for farmer engagement, research, and market development. With decisive action, Colorado can establish itself as a key node in a regional SAF supply chain, supporting rural economies while advancing national decarbonization objectives.

3.4 Additional oilseed crops

3.4.1 Carinata - Overview

Carinata (Brassica carinata), also known as Ethiopian mustard, is a non-food oilseed crop with established commercial cultivation in the southeastern United States, where it is utilized primarily for the production of SAF. Carinata is valued for its high erucic acid content and its ability to be grown as a rotational winter crop, particularly in mild climates with sufficient winter moisture.

While the crop has demonstrated strong agronomic and economic performance in states like Florida and Georgia, its adaptability to Colorado remains largely untested. There is no publicly available data on carinata trials or active research plots taking place in Colorado. Preliminary assessments suggest that the state's climatic conditions—especially in its high-elevation zones—pose substantial challenges to the winter survivability and yield potential of carinata. Given the lack of supporting data and infrastructure, carinata is considered a low-readiness option for SAF feedstock production in the state at this time.

Sustainability Analysis

Evaluated against ICAO's CORSIA sustainability criteria, carinata performs well as a cover crop where it has been tested:

- **GHG Reduction:** Carinata-derived HEFA SAF has shown lifecycle GHG emission reductions exceeding 70% compared to fossil jet fuel, positioning it favorably among low-carbon fuels (SPARC, 2024).
- **Carbon Stock and Permanence:** As a non-perennial crop with shallow rooting systems, carinata is unlikely to impact long-term carbon stock. Its cultivation on existing farmland avoids land use change.
- **Water and Soil:** In its primary growing regions, carinata requires moderate water input and contributes to soil conservation when used as a cover crop. However, Colorado's arid and high-altitude environments may necessitate supplemental irrigation or expose the crop to frost damage, undermining its sustainability profile.
- **Human and Labor Rights, Land Use, and Food Security:** Carinata is a non-food crop and does not compete with food production, supporting positive sustainability outcomes in land use and food security.

The default core LCA results for the carinata HEFA pathway is 34.4 g CO_2e/MJ. The following table shows the LCA values for carinata. Note that this LCA default value is for carinata as a summer crop in northern US and Canada. The LCA for carinata as a winter cover crop has yet to be considered, which could impact the core LCA results illustrated here:

Table 13 - - LCA result for carinata HEFA pathway [g CO2e/MJ]

Feedstock	Data source	Model	Cultivation	Feedstock transportation	Oil extraction	Oil transportation	Feedstock to fuel conversion	Fuel transportation	Total
Brassica Carinata	US /Canada	GREET	15.4	0.6	3.9	0.4	13.7	0.4	**34.4**

Source: CORSIA supporting document — Life cycle assessment methodology

Despite carinata's strengths, the crop's practical sustainability in Colorado is questionable. Carinata's cold sensitivity and higher water requirements relative to camelina make it a poor fit for the state's semi-arid and high-altitude agricultural zones. Without empirical lifecycle assessments specific to Colorado conditions, sustainability certification readiness remains speculative.

Feedstock Analysis

In the southeastern United States, carinata yields range between 2,000 to 2,500 lbs/acre, with an oil content of 38–42% (University of Florida IFAS, 2024). Based on these metrics, one acre of carinata can yield roughly 85 to 105 gallons of oil suitable for SAF conversion. However, these yields are achieved in regions with mild winters, ample precipitation, and established agronomic practices tailored to the crop.

In contrast, Colorado presents several agronomic challenges for carinata production:

- Cold Tolerance: Carinata is not frost-hardy. Much of Colorado experiences severe winter temperatures, particularly in the Western Slope and mountain counties, rendering fall planting impractical without new cold-tolerant varieties.
- Water Requirements: Carinata's growing season overlaps with winter and early spring, periods during which irrigation is limited and precipitation is unreliable in Colorado.
- Growing Degree Days and Elevation: Colorado's high elevation and short growing season limit the crop's potential to reach maturity before the onset of heat or late frosts, particularly in northern and western regions.

While eastern Colorado and low-elevation counties such as Montrose or Delta may offer some limited potential for trial cultivation, these regions already support more suitable oilseed alternatives like camelina. No known yield trials, extension services, or industry initiatives currently support carinata in Colorado.

Opportunities and Considerations

Opportunities:

- Rotation Potential: Carinata could serve as a rotational crop on fallow winter wheat land in low-elevation, frost-free areas of southeastern Colorado.
- Emerging Market Demand: SAF producers have expressed interest in carinata oil due to its high erucic acid content and strong GHG reduction profile under HEFA.
- Pollinator Benefits: Early-season flowering may benefit pollinators, as observed in southeastern trials (Peoples Company, 2024).
- Mature conversion technology

Considerations:

- Climate Unsuitability: Colorado's elevation and winter temperature extremes are significant barriers. Unlike camelina, carinata lacks cold tolerance and requires milder winter conditions.
- Lack of Agronomic Support: No regional research programs, breeding efforts, or CSU extension services seem to be focusing on carinata.
- Infrastructure Gaps: There is no local crushing or processing capacity for carinata in Colorado. This necessitates out-of-state transportation of raw seed—adding costs and emissions.
- Farmer Adoption Risks: With no market assurance or crop insurance, farmers face high risks when adopting carinata. This contrasts sharply with camelina, which already benefits from local trials and exploratory contracting.

Conclusion and Key Findings

While carinata has proven value as a SAF feedstock in the southeastern U.S., its outlook in Colorado is presently unfavorable. The crop is not cold-hardy, lacks local agronomic support, and does not align with current climatic or infrastructural realities in most of the state's agricultural zones. In Western Colorado, where high elevation and limited water define the growing environment, carinata faces even greater obstacles.

Opportunities for trial production may exist in lowland southeastern counties, but success would depend on extensive breeding for cold tolerance and establishment of localized processing infrastructure. In contrast to camelina, which has demonstrated adaptability and early-stage support in Colorado, carinata represents a speculative and high-risk option for SAF feedstock development in the near-term. Nevertheless, carinata merits monitoring as part of a long-term diversification strategy on SAF feedstock investment in Colorado.

3.4.2 Soybean and Canola - Overview

Soybean and canola seeds are high-oil-content crops widely cultivated for food, feed, and fuel purposes. Both crops are recognized as eligible feedstocks for SAF production via HEFA. Unlike camelina, which is a winter crop, soybean and canola are typically planted in the spring and harvested in the late summer or early fall. This seasonal difference means soybean and canola compete directly with summer crops such as sweet corn, forage sorghum, and alfalfa. Their viability as SAF feedstocks must therefore be evaluated within the context of agronomic fit, opportunity cost, and regional water availability (USDA ERS, 2023).

Co-products such as canola and soybean protein meal are established inputs into livestock feed markets, increasing the economic attractiveness of the value chain. Canola oil offers slightly higher oxidative stability, while soybean oil benefits from global processing ubiquity. Both have well-established supply chains in contrast to emerging crops like camelina. In fact, as reported by Ph.D. Todd Ballard, Tri-River Area Agronomy Specialist, the current demand for soybean in the swine operations of eastern CO could make for an immediate market.

Canola and soybean oils are processed using HEFA technology. Oil is extracted through mechanical or solvent-based methods, then hydroprocessed into SAF and other distillates.

Sustainability Analysis

The greenhouse gas (GHG) emission profiles of canola and soybean vary by growing region and agricultural practice. Both crops are capable of achieving CORSIA-compliant requirements, mainly:

- **GHG Reduction:**
  - Canola and soybean can achieve CORSIA-compliant GHG reductions, typically ranging from 40–60% below fossil jet fuel.
  - Camelina often exceeds 60% GHG reduction due to its lower input requirements and winter growth cycle.
- **Water and Input Needs:**
  - Canola is moderately drought-tolerant and can be grown under limited irrigation in semi-arid areas.
  - Soybean generally has higher water requirements, limiting its suitability in drier regions.
  - Soybean's fertilizer and pesticide needs are greater than camelina’s, increasing upstream GHG emissions and risks of nutrient runoff.
- **Certification and LCA Readiness:**

  - Both crops are compatible with RSB and ISCC certification schemes.
  - Robust LCA data exists for both, supporting approval under CORSIA.
- **Land Use Change (LUC) Risks:**
  - Expansion of soybean or canola may displace high-value summer crops (e.g., sweet corn, forage sorghum), potentially leading to indirect emissions and food production tradeoffs (USDA ERS, 2023). Camelina, typically grown on fallow land or within winter wheat rotations, avoids these conflicts (Shonnard et al., 2010).

Feedstock Analysis

The Western Slope of Colorado presents moderate agronomic challenges for soybean and limited opportunity for canola production, primarily due to water scarcity and short growing seasons. While camelina is well-suited to winter fallow systems, soybean and canola require spring planting and compete with valuable summer crops like sweet corn or hay. Local CSU Extension agents note that canola has shown limited viability in dryland trials, and soybean is rarely grown without significant irrigation support.

The combined oil output from soybean and canola in the Western Slope is significantly lower than that for camelina, which represented 11.2% of the oil feedstock required by a single HEFA refinery. Based on available spring crop acreage, canola could yield approximately 3,652 metric tons and soybean around 2,988 metric tons of oil annually (Colorado State University Extension, 2023). These figures represent only 0.39% and 0.32%, respectively, of the 934,940 metric tons needed to operate a commercial-scale HEFA refinery at full capacity. This contrast underscores the limited capacity of spring-planted oilseeds in Western Colorado to serve as standalone SAF feedstocks and reinforces the importance of integrating them with winter crops like camelina or sourcing additional volumes from other regions.

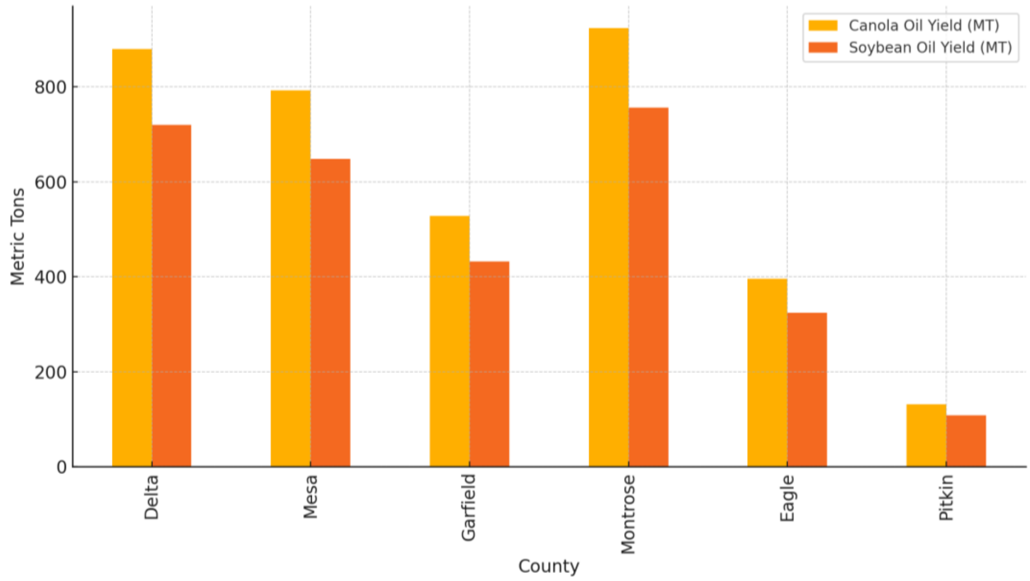
The following table and consequent graph represent the estimated oil yields for canola and soybean taking into consideration acreage used for spring crops specific to the Western Slope of Colorado:

Table 14 - - Estimated oil yields from spring crops in the Western Slope of Colorado

County	Spring Crop Acreage	Canola Oil Yield (MT)	Soybean Oil Yield (MT)
Delta	2000	880	720
Mesa	1800	792	648
Garfield	1200	528	432
Montrose	2100	924	756
Eagle	900	396	324
Pitkin	300	132	108
Total	**8300**	**3,652**	**2,988**

Source: USDA NASS (2022), Colorado State University Extension (2023), USDA ERS (2023), Colorado Department of Agriculture (2024)

Figure 8 - Estimated oil yield for Western Slope



Source: Savia Consulting

Expanded Regional Potential for Soybean/Canola Production

Beyond the Western Slope, Central and Eastern Colorado offer more promising environments for spring oilseed crops. In Central Colorado, small irrigated valleys may support canola in a spring rotation. Soybean remains limited due to elevation and short growing seasons.

Eastern Colorado presents the strongest case for soybean and canola production, with flatter terrain, extensive center-pivot irrigation systems, and established commodity infrastructure. However, adoption would require farmers to shift land away from high-value crops like irrigated corn, sunflowers, or forage sorghum. This opportunity cost must be factored into SAF supply planning.

Estimated production capacity in this region for canola oil is approximately 207,360 metric tons, while soybean oil could reach 172,800 metric tons annually. These volumes represent 22.2% and 18.5%, respectively, of the 934,940 metric tons of oil required to operate a single commercial-scale HEFA refinery at full capacity. Central Colorado, in contrast, contributes far less—approximately 1,188 metric tons of canola oil and 972 metric tons of soybean oil—representing only 0.13% and 0.10% of the same refinery demand (Colorado State University Extension, 2023). Collectively, this underscores the importance of Eastern Colorado in SAF feedstock strategy development while highlighting the need to supplement regional oil volumes with winter crops such as camelina or imports from surrounding agricultural states.

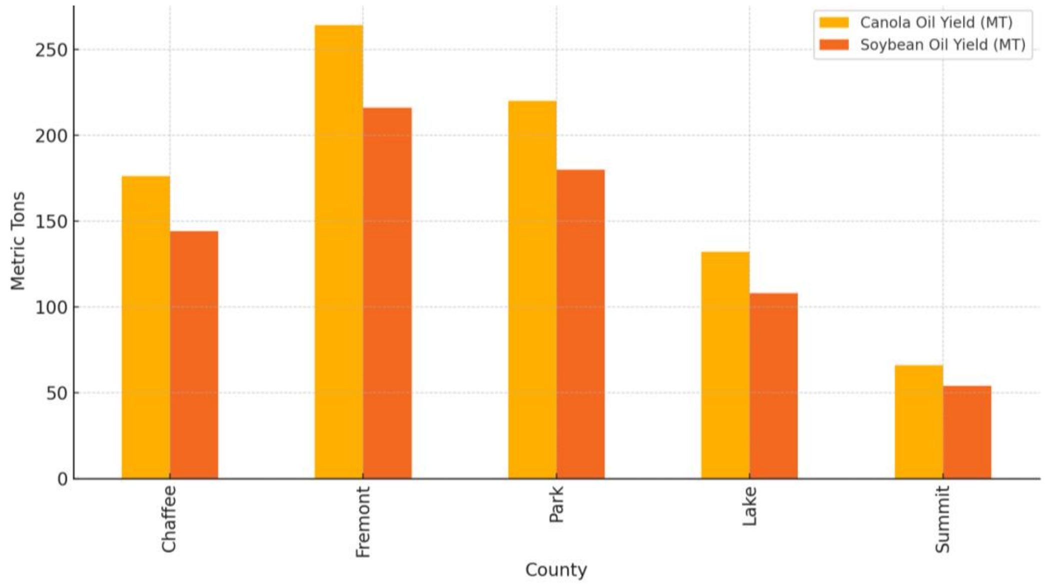
The following table and consequent graph represent the estimated oil yields for canola and soybean taking into consideration acreage used for spring crops specific to the Central Colorado region:

Table 15 - Estimated oil yields from spring crops in Central Colorado

County	Spring Crop Acreage	Canola Oil Yield (MT)	Soybean Oil Yield (MT)
Chaffee	400	176	144
Fremont	600	264	216
Park	500	220	180
Lake	300	132	108
Summit	150	66	54
Total	**1950**	**858**	**702**

Source: Colorado State University Extension (2023), USDA ERS (2023), USDA NASS (2022)

Figure 9 - Estimated oil yields from Central Colorado



Source: Savia Consulting

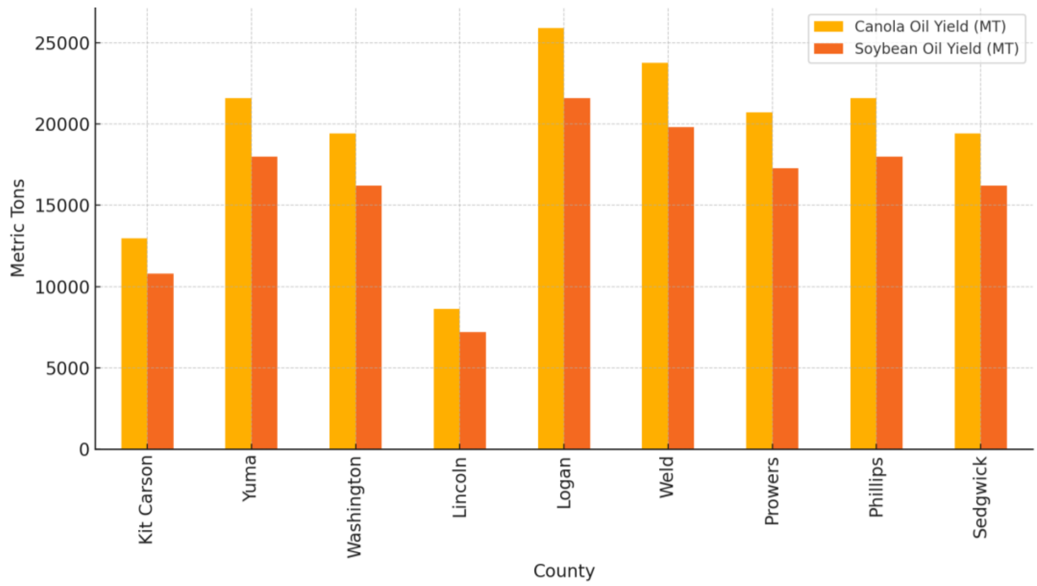
The following table and consequent graph represent the estimated oil yields for canola and soybean taking into consideration acreage used for spring crops specific to Eastern Colorado region:

Table 16 - - Estimated Oil Yields from Spring Crops in Eastern Colorado

County	Spring Crop Acreage	Canola Oil Yield (MT)	Soybean Oil Yield (MT)
Kit Carson	30000	12,960	10,800
Yuma	50000	21,600	18,000
Washington	45000	19,440	16,200
Lincoln	20000	8,640	7,200
Logan	60000	25,920	21,600
Weld	55000	23,760	19,800
Prowers	48000	20,736	17,280
Phillips	50000	21,600	18,000
Sedgwick	45000	19,440	16,200
Total	**403000**	**174,096**	**145,080**

Source: USDA NASS (2022), Colorado State University Extension (2023), USDA ERS (2023), Colorado Department of Agriculture (2024)

Figure 10 - Estimated oil yield for Eastern Colorado



Source: Savia Consulting

Out-of-State Sourcing Potential for Soybean and Canola

Although Colorado—especially the Eastern Plains—offers meaningful in-state potential for soybean and canola oil production, it falls short of meeting the total feedstock volume required by a single commercial-scale HEFA refinery (934,940 metric tons of oil per year). Also, estimates for Colorado consider 100% adoption by farmers which it is not a realistic approach in the short to medium term, more acceptable in the long term.

To address this shortfall, out-of-state sourcing from nearby agricultural states presents a viable pathway. Neighboring states such as Kansas, Nebraska, and Oklahoma are major producers of soybean and canola, with well-established commodity infrastructure and rail connectivity to Colorado. These states operate within similar agroecological zones, making them strategically aligned for supply chain integration.

The table below summarizes soybean and canola production trends in these states, highlighting their relevance for supplementing Colorado's SAF feedstock supply.

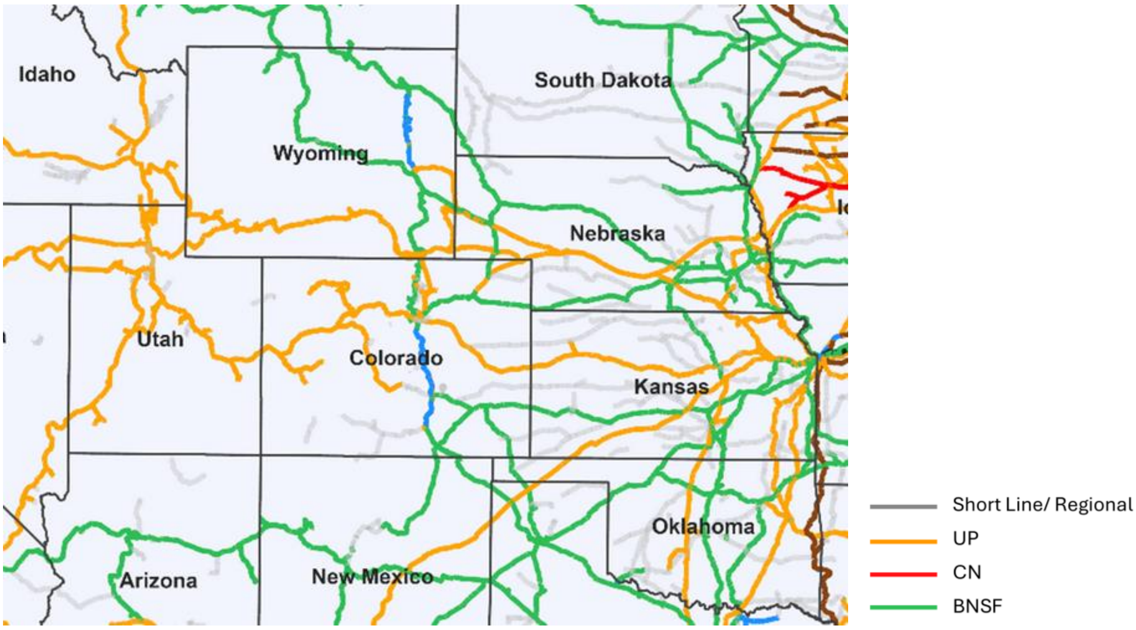
Table 17 - Regional Contribution of Oilseed Feedstocks to HEFA Refinery Demand

State	Crop	2023 Harvested Acreage	Average Yield (lbs/acre)	Estimated Oil Yield (MT)	Notes
Kansas	Soybean	4,150,000 acres	2,250	~360,000	Extensive soybean infrastructure; some local crush facilities
Kansas	Canola	110,000 acres	1,700	~37,000	Winter canola adapted to southern Kansas; supported by Oklahoma markets
Nebraska	Soybean	5,300,000 acres	2,700	~490,000	One of the top 10 soybean-producing states nationally
Nebraska	Canola	<10,000 acres	N/A	<3,000	Minimal current production; could be expanded with demand
Oklahoma	Soybean	510,000 acres	2,150	~45,000	Grown mostly in the northeast; emerging interest in energy markets
Oklahoma	Canola	215,000 acres	1,800	~72,000	Longstanding winter canola acreage; part of wheat rotation systems

Source: USDA NASS (2023); USDA ERS (2023); Kansas State University Extension (2023); Oklahoma State University Canola Program (2023)

Each of these states operates within freight rail corridors that link directly to Colorado's refining and processing hubs, including BNSF and Union Pacific Class I rail lines. With appropriate infrastructure investment—such as aggregation hubs and transloading terminals—oil or seed could be shipped in bulk for processing within Colorado.

Figure 11- Freight corridors linked to CO from neighbouring states



Source: Association of American Railroads

Moreover, existing oilseed crushing and storage infrastructure in Kansas and Nebraska can enable upstream value addition, reducing the need for raw seed transport and enhancing cost-efficiency.

Leveraging this out-of-state sourcing opportunity provides several strategic benefits:

- Volume Assurance: Helps close the gap between in-state production and refinery-scale demand.
- Market Resilience: Diversifies supply to mitigate local drought or crop failure risks.
- Infrastructure Synergy: Aligns with existing rail and oilseed processing capacity in the region.

As Colorado builds its SAF supply chain, multi-state collaboration with Kansas, Nebraska, and Oklahoma can provide the supplemental volumes needed to ensure refinery viability and supply chain stability. Similarly, sourcing from neighboring states serves as a transitional step until soybean and canola become established crops across Colorado.

Opportunities and Considerations

Canola and soybean offer unique opportunities for SAF feedstock expansion in Colorado, particularly in irrigated areas of the Eastern Plains. Their mature global markets, established oil extraction infrastructure, and marketable co-products position them as strong complements to camelina in a multi-feedstock SAF strategy.

However, the opportunity cost of displacing high-value summer crops is significant. In many cases, adopting soybean or canola would require producers to forgo crops like sweet corn, dry beans, or alfalfa—each of which commands higher prices or serves critical local food or forage needs. This risk is heightened in the Western Slope, where water limitations and crop diversity make summer land use decisions more economically sensitive.

Infrastructure gaps, particularly a lack of local oilseed crushing capacity and transport networks, could delay market entry. Adoption incentives, technical assistance, and targeted subsidies for SAF feedstock conversion will be needed to de-risk the transition for growers.

Soybean and canola offer meaningful—but regionally constrained—opportunities for expanding SAF feedstock capacity in Colorado. Their well-established global markets, mature crushing infrastructure in nearby states, and valuable co-products make them suitable candidates for inclusion in a multi-feedstock strategy.

The table below summarizes estimated annual oil yields from soybean and canola across Colorado's major agricultural regions, along with the percentage of oil required to operate a commercial-scale HEFA refinery that each region could potentially supply. These figures highlight the dominant role of Eastern Colorado in statewide oilseed potential and illustrate the relatively lower contributions from the Central region and Western Slope.

Table 18 - Annual Canola & Soybean Oil Yield Statewide in CO and Share of HEFA Refinery Demand

Region	Crop	Estimated Annual Oil Yield (MT)	% of HEFA Refinery Requirement (934,940 MT)
Western Slope	Canola	3,652	0.39
	Soybean	2,988	0.32
	Total	**6,640**	**0.71**
Central Colorado	Canola	858	0.09
	Soybean	720	0.08
	Total	**1,560**	**0.17**
Eastern Colorado	Canola	174,096	18.62
	Soybean	148,770	15.91
	Total	**380,160**	**40.66**

Despite their scalability in the East, soybean and canola face important limitations:

- In the Western Slope and Central regions, limited water availability and competing summer crop demands constrain adoption.
- Substituting these crops may displace high-value crops such as sweet corn or forage sorghum (USDA ERS, 2023).
- Local oilseed crushing infrastructure remains insufficient, requiring regional investment or coordination with existing facilities.
- Adoption risks—especially for soybean—are elevated due to higher input costs and inconsistent profitability in water-stressed zones.

To unlock potential, strategic incentives—such as contracts for SAF-linked oil delivery, technical assistance, and subsidies—will be essential to support farmer transition and de-risk participation.

Conclusion and Key Findings

Soybean and canola hold measurable potential as SAF feedstocks in Colorado, though their scalability is highly dependent on regional suitability and infrastructure. Among all regions, Eastern Colorado stands out, capable of supplying approximately 40.66% of a HEFA refinery's annual oil requirement (934,940 MT) from soybean and canola combined. In contrast, Central and Western Colorado together contribute less than 1% each, reflecting significant agronomic and economic constraints on spring-planted oilseed crops in those areas.

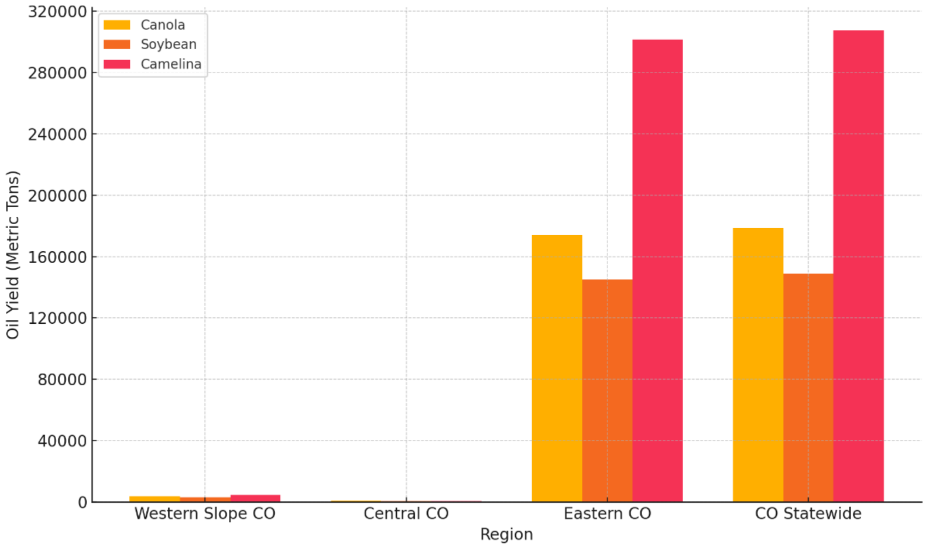
When these contributions are compared to camelina, an oilseed suited for winter rotations, the difference is more pronounced. Camelina production from winter wheat land across Colorado could yield 307,204 MT of oil annually, meeting 33% of a refinery's needs. This includes 4,774 MT from the Western Slope alone, far outpacing the spring oilseed alternatives in that region.

The following two figures illustrate the relative contributions of each oilseed crop by region, a visual summary of the distribution and scale of oil production potential across Colorado:

Table 19 - Potential canola, soybean, and camelina annual oil yields CO Statewide

CO Regions	Canola Oil Yield (MT)	Soybean Oil Yield (MT)	Camelina Oil Yield (MT)
Western Slope	3,652	2,988	4,776
Central	858	702	789
Eastern	174,096	145,080	301,675
Sub-total	178,606	148,770	307,240
Total statewide potential yields of canola + soybean + camelina			**634,616**

Figure 12 - Potential canola, soybean, and camelina annual oil yields CO Statewide – bar chart



Source: Savia Consulting

This data reinforces a few key strategic insights:

- Camelina is the most regionally adaptable oilseed in Colorado, particularly in the Western and Central regions.
- Soybean and canola, though limited in the west, are highly scalable in Eastern Colorado, where irrigated acreage and established markets offer near-term feasibility.
- *A blended strategy* that integrates camelina, soybean, and canola—each leveraged in their optimal regional context—*could cover up to 68% of a commercial-scale HEFA refinery's oil feedstock needs, as shown in the final bar of the chart.*

To capitalize on this opportunity, Colorado will need:

- Policy incentives to de-risk transitions from high-value food crops to energy crops.
- Infrastructure investment in oilseed crushing and storage.
- Outreach to growers to align SAF feedstock production with existing rotations and water use patterns.

This multifaceted oil-based feedstock approach can support Colorado's leadership in SAF production while balancing agronomic, environmental, and economic priorities

3.5 Agricultural Residues - Waste from Sweet corn, Corn stover and wheat straw

Sweet corn production in Western Colorado generates significant agricultural waste that can serve as a feedstock for SAF. The primary source of sweet corn waste includes stalks, husks, cobs, and culled ears left after harvest and processing. The Tuxedo Corn Company, located in Olathe, Colorado, is a major producer of Olathe Sweet™ Sweet Corn, which is exclusively harvested by hand. Sweet corn cultivation in Western Colorado spans approximately 8,000 acres, with production concentrated in Montrose, Delta, and Mesa counties (Colorado State Extension).

Corn stover and wheat straw are significant agricultural residues that can serve as SAF feedstocks. Nationally, corn stover availability is estimated at 80-120 million dry tons annually, with wheat straw contributing a substantial portion of additional biomass (Energy.gov).

3.5.1 Sustainability Analysis

Corn stover, wheat straw, and sweet corn waste are agricultural residues that align well with ICAO's CORSIA framework for SAF. As byproducts of existing crops, they are not intentionally cultivated and thus qualify as low-ILUC (Indirect Land Use Change) materials. Utilizing these residues supports waste reduction, avoids food-versus-fuel concerns, and aligns with circular bioeconomy principles.

Lifecycle greenhouse gas emissions for SAF derived from lignocellulosic residues can achieve reductions exceeding 80% compared to fossil jet fuel. When processed through FT or pyrolysis, these residues can yield SAF with carbon intensities below 20 gCO_2e/MJ, depending on the efficiency of logistics and preprocessing.

Sustainability advantages include:

- Minimal water and chemical inputs
- No impact on food security
- Compatibility with existing agricultural operations
- Eligibility under CORSIA and RED II sustainability frameworks

However, residue removal must be carefully managed to maintain soil health. Sustainable harvesting typically allows for 30–50% of residue removal, depending on local soil conditions and erosion risks (USDA NRCS, 2022).

3.5.2 Feedstock Availability

Based on USDA Agricultural Census and crop acreage records (USDA NASS, 2022), the estimated regional availability of recoverable corn stover, wheat straw, and sweet corn waste in the six-county Western Slope study area is approximately 65,236 metric tons annually.

Table 20 - Estimated Crop Residue Volumes for SAF in the Western Slope Region

County	Corn Acres	Corn Stover (MT)	Sweet Corn Acres	Sweet Corn Waste (MT)	Wheat Acres	Wheat Straw (MT)
Delta	6,402	22,407	N/A	N/A	1,496	2,244
Mesa	3,047	10,665	N/A	N/A	1,639	2,459
Montrose	7,090	24,815	1,323	2,646	N/A	N/A
Sub-total	16,539	57,887	1,323	2,646	3,135	4,703
					Total Recoverable Biomass MT	65,236

While these volumes may be notable for some rural regions, they fall well short of the feedstock requirements needed to support even a small-scale SAF refinery. As illustrated below, ICAO's Rules of Thumb indicate that a pioneer-scale FT plant would require over 550,000 MT/year of biomass, which is nearly 10 times more than the region can currently supply; pyrolysis plants need even more feedstock volumes:

Table 21 – Agricultural Residue needed to Operate a FT-to-SAF Refinery

Operator	Plant Capacity MT/Yr	Agro. Residues MT/Yr	SAF Output MT/Yr
RoT – nth plant:	232,800	1,662,857	93,120
RoT – pioneer plant:	77,600	554,285	31,040

Source: Savia Consulting using date from ICAO's Rules of Thumb

Table 22 - - Agricultural Residue needed to Operate a Pyrolysis SAF Refinery

Operator	Plant Capacity MT/Yr	Agro. Residues MT/Yr	SAF Output MT/Yr
RoT – nth plant:	310,400	1,349,565	139,680
RoT – pioneer plant:	77,600	337,391	31,040

Source: Savia Consulting using date from ICAO's Rules of Thumb

3.5.3 Regional Collection and Infrastructure

Delta, Montrose, and Mesa Counties account for over 85% of the region's crop residue volumes. These counties also benefit from existing agricultural infrastructure and transport access that could support seasonal biomass aggregation.

Key logistical considerations include:

- Baling, transportation, and storage
- Densification and preprocessing
- Compliance with soil conservation standards

However, there is currently no commercial-scale infrastructure for collecting and processing agricultural residues for SAF. While small-scale biomass collection exists (e.g., for composting or livestock bedding), scaling up would require significant investment and coordination.

3.5.4 Opportunities and Considerations

Opportunities:

- Readily available, low-cost residues for thermochemical SAF pathways
- Regional clustering of biomass production allows for targeted collection efforts
- High GHG reduction potential supports compliance with international sustainability criteria

Considerations:

- Current biomass volumes are insufficient to support even a small commercial SAF facility
- Residue collection logistics and infrastructure are underdeveloped
- Only a fraction of total biomass is sustainably harvestable
- Seasonality may limit year-round availability, requiring blending or supplemental feedstocks

3.5.5 Conclusion and Key Findings

Agricultural residues such as corn stover, wheat straw, and sweet corn waste offer valuable feedstock opportunities for SAF production. However, in Western Colorado the total annual recoverable volume of approximately 65,000 MT is far below the threshold needed to support a commercial-scale SAF refinery. Even a pioneer-scale FT plant would require nearly ten times that amount.

The Western Slope's crop residue stream may instead serve as a supplementary feedstock in a blended SAF strategy, potentially integrated with forestry waste or municipal solid waste. While logistical and sustainability challenges remain, leveraging these residues can contribute to a more diversified and regionally appropriate SAF value chain aligned with CORSIA standards and rural development goals.

3.6 Forestry residues - Overview

Primary forest residues (PFR), including branches, sawdust, bark, dead trees, and other biomass by-products from logging and forest management activities are usually considered to have minimal or no commercial value. As a result, they are often left to decompose in the forest, releasing greenhouse gases such as carbon dioxide and methane, or are otherwise disposed of through methods such as open burning, which contributes to air pollution.

In the Western Slope and Front Range, logging residues, including treetops and branches, are available from forestry operations and land management agencies. The Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests in Western Colorado produce significant volumes of logging residues through timber harvesting and forest management activities (Corgan Insights). Additionally, private forestry operations contribute to residue availability, with companies such as West Range Reclamation in Hotchkiss and Colorado engage in sustainable logging practices that generate biomass suitable for SAF conversion.

Secondary forest residues (SFR) are generated as by-products of industrial wood processing operations. These include materials such as sawdust, bark, sawmill slabs, and wood chips, which frequently present a disposal challenge for processing facilities. Sawdust and wood shavings are primarily sourced from timber processing facilities such as Montrose Forest Products in Montrose, Colorado, and Intermountain Resources in Montrose, Colorado. These facilities generate volumes of sawmill residues through lumber processing operations (USDA Forest Service).

Despite their limited market value, both primary and secondary forest residues can be collected and converted into valuable energy products such as bio-oil, cellulosic ethanol, or syngas, which can subsequently be refined into SAF. They can also be used to produce renewable energy.

There are four pathways that can convert forestry residues into aviation fuel: FT, AtJ, MtJ and pyrolysis. The pathways can use a mix of feedstocks, including woody biomass, MSW, agricultural waste and waste gases. No commercial plants currently operate with multiple feedstocks, but several companies are actively developing the technology.

This section analyzes the available quantity of forestry residues that can be transformed into SAF using primary and secondary data obtained from the USFS In the Grand Valley and White River Forest Service, Mesa County Natural Resources, and the Colorado Department of

Agriculture. Due to the unavailability of forestry production companies such as Montrose Forest Production and Redemption Sawmill, data for SFR was obtained from publicly available sources such as the Colorado Forest Products Database and the Colorado Forest Carbon Inventory.

3.6.1 Sustainability Analysis

Forestry residues rank well on nearly all ICAO CORSIA sustainability criteria:

- **GHG:** SAF made from forestry residues can reduce lifecycle GHG emissions by over 60%. Repurposing forestry residues to aid wildfire prevention prevents local air pollution.
- **Land Use and Food Security:** Using forestry residues avoids land use expansion or food crop displacement.
- **Water and Soil Impact:** Minimal impact on water and soil, as they are by-products of managed forests rather than newly cultivated biomass or energy.
- **Certification Readiness:** Eligible under several recognized sustainability certification systems, including RSB and ISCC.

The default core LCA results for the SAF produced from forestry residues varies 8.3 for the FT pathway to 23.8 for ATJ. The following tables illustrate the parameters considered and how the LCA for the US compares to other regions:

Table 23 - LCA for or forest residue FT pathways [gCO2e /MJ]

Feedstock	Data provider	Model	Feedstock cultivation and collection	Feedstock transportation	Feedstock-to- fuel conversion	Fuel transportation	Total	Midpoint value
Forest Residues	MIT	GREET	1.4	3.8	0	0.9	**6.1**	**8.3**
	JRC	GREET	2.4	3.8	0	0.9	**7.1**	
	JRC	E3	3.3	2.9	4	0.3	**10.5**	

Source: CORSIA supporting document — Life cycle assessment methodology

Table 24 - LCA for the forest residue iso-butanol ATJ pathway [gCO2e/MJ]

Feedstock	Data Provider	Model	Feedstock collection	Feedstock transportation	Feedstock-to- fuel conversion	Fuel transportation	Total emissions	Midpoint value
Forest Residues	MIT	GREET	1.6	2.1	20.5	0.5	**24.7**	**23.8**
	JRC	E3	3.9	3.6	15	0.3	**22.8**	

Source: CORSIA supporting document — Life cycle assessment methodology

3.6.2 Feedstock Analysis

Forestry residues represent a highly promising SAF feedstock for Colorado's Western Slope due to the region's proximity to several national forests, including the White River, Grand Mesa, Gunnison, Uncompahgre, and San Juan National Forests. Both the U.S. Forest Service (USFS) and private forestry companies—such as West Range Reclamation and Vegetation Management West—produce biomass waste through sustainable logging and forest management practices. These residues include treetops, branches, and dead or diseased trees, such as beetle-killed pine.

In addition, woody biomass is generated by lumber and wood processing operations across the region. Facilities such as Montrose Forest Products, Intermountain Resources, and Redemption sawmill produce significant volumes of by-products including sawdust, wood shavings, bark, and other mill residues.

The quantity of forestry residues needed to for a SAF facility depends on the SAF technology, as well as factors such as moisture and lignin content which have an impact on conversion efficiency. The following tables show the required volume for the FT, AtJ and Pyrolysis pathways using ICAO SAF Rules of Thumb conversion factors and publicly available data from existing facilities.

Table 25 - Forestry Residue needed to Operate a FT-to-SAF Commercial Refinery

Operator	Plant Capacity MT/Yr	Forestry Residues MT	SAF Output MT/Yr
Red Rock Biofuels	52,899	175,000	21,231
RoT – nth plant	310,400	1,724,444	124,160
RoT – pioneer plant	77,600	431,111	31,040

Source: Savia Consulting using data from Redrock Biofuels (Biofuels USA) and the ICAO SAF Ruf Thumb. Note that only the density of SAF is used for unit conversion purposes for RoT.

Table 26 - Forestry Residue needed to Operate a Pyrolysis-to-SAF Commercial Refinery

Operator	Plant Capacity MT/Yr	Forestry Residues MT/Yr	SAF Output MT/Yr
RoT – nth plant	310,400	1,349,565	139,680
RoT – pioneer plant	77,600	337,391	31,040

Source: Savia Consulting using data from the ICAO SAF Ruf Thumb. Alder Renewables does not provide any public feedstock or SAF figures. Note that only the density of SAF is used for unit conversion purposes for RoT.

Table 27 - Forestry Residue needed to Operate a AtJ-to-SAF Commercial Refinery

Operator	Plant Capacity MT/Yr	Ethanol MT/Yr	SAF Output MT/Yr
RoT – nth plant:	776,000	1,293.333	543,200
RoT – pioneer plant:	77,600	129,333	54,320

Source: Savia Consulting using data from the ICAO SAF Ruf Thumb and study by energies journal. There is no facility producing SAF entirely from forestry residues.

Discussions with multiple stakeholders in the USFS and Colorado Department of Agriculture rev ealed that there is no data on current amounts of PFR produced annually on the Western Slope; available data was published over a decade ago. However, a study by the USDA Forest Service, estimates that state-wide Colorado produces approximately 279,000 to 1.5 million oven-dry tons of forest biomass annually. The Colorado State Forest Service estimates that there are over 800 million dead standing trees in Colorado as well as hundreds of thousands of cut trees in log piles, weighing several thousand pounds each. Although weight depends on many factors such as height and tree diameter, moisture content, decay, and other factors, according to a report from the USFS, a dead tree can weigh from 400 to over 1000 lbs (0.2-0.5 MT). This means that there are potentially 160-400 million tons of forestry residue available from dead trees for SAF processing.

SFR also represents a significant feedstock category for SAF production in Western Colorado. Estimating the annual generation of wood processing residues in Western Colorado is challenging due to the lack of region-specific data. A 2004 study by the USFS estimated that along the Colorado Front Range, wood processing facilities have the potential generate significant amounts of wood waste per year. While this study focused on the Front Range and has decades old data, it provides a rough estimate of waste generation that may be applicable to Western Colorado.

The tables above show that it takes a very large amount of forestry residues to supply a SAF plant, regardless of the conversion pathway. When comparing with the average available volumes of PFR biomass and dead trees,

Forestry Residue SAF Case Studies:

- LanzaJet through its CIRCULAIR initiative, is currently developing multi-feedstock conversion technologies for SAF production.
- Enerkem pioneered the conversion of forestry residues and MSW into SAF using the AtJ process, it has yet to demonstrate successful commercial-scale operations. Its Edmonton plant shut down early, and the company recently sought creditor protection amid restructuring. Funding shortfalls halted a Quebec waste-to-methanol project, while a separate Spanish initiative was cancelled.
- Velocys. plans to build the Bayou Fuels facility in Natchez, Mississippi, using cellulosic woody biomass. The plant is expected to produce 25 million gallons of SAF and 10 million gallons of renewable naphtha annually.
- Red Rock Biofuels, began constructing a SAF facility in Lakeview, Oregon, using woody biomass. After declaring bankruptcy before completion, NEXT Renewable Fuels acquired its assets and plans to finalize the project, repurposing it for renewable natural gas production.
- Two Colorado-affiliated companies are advancing fast pyrolysis. Alder Renewables, with an R&D facility in Louisville, Colorado, recently launched a Quebec project using woody biomass for SAF production. Charm Industrial, operating in Fort Lupton, Colorado, focuses on bio-oil production and sequestration, monetizing carbon credits.

calculations estimate that there is enough forestry residues within the evaluated study area in the Western Slope to support a SAF plant for its 20-year lifespan:

Table 28 - Forestry Residue Supply vs FT nth-Plant Demand

ICAO RoT – FT nth Plant	MT/year
Sustainable annual PFR supply	889,500
Sustainable annual dead-tree supply (3.7% annual harvest rate)	10,400,000
Total annual supply	**11,298,500**
FT nth-plant feedstock requirement	1,724,444
Surplus capacity	**9,565,056**

Source: Savia Consulting

Because the region contains more standing dead trees than the facility requires, it is useful to identify the minimum harvest needed to supply a Fischer Tropsch SAF plant. The table below shows that, although the required harvest involves many trees, the annual removal represents only a small fraction of the total inventory.

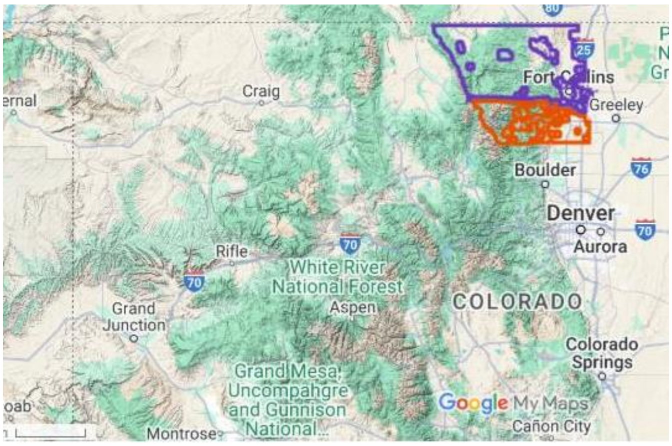
Table 29 - Dead tree biomass required for a FT SAF plant

Forestry Residues Needed for ICAO Rot Nth plant MT/Yr	1,724,444
Dead trees needed to be cut per year	4,926,980
Percentage of dead tree inventory needed	**47.4 %**

Source: Savia Consulting

Larimer Conservation district cuts down 40,000 trees per year in a relatively small percentage of the total available forested area which demonstrates the potential to generate the required biomass.

Figure 13 - Are covered by the Larimar Conservation District



Source: Larimer Conservation District

SUSTAINABLE AVIATION

3.6.3 Opportunities and Considerations

While forestry residues offer significant potential as a feedstock for sustainable aviation fuel SAF production in the Western Slope region, several key challenges must be addressed to ensure economic and operational viability.

Opportunities:

- Transforming forestry residues into SAF will have a major environmental benefit by reducing the risk of wildfires and reducing methane emissions from decomposing waste.
- Collection, transport, storage, and processing forestry residues will provide jobs in the declining forestry industry and economic benefits for rural communities.
- Using SFR form wood processing plants will create another revenue source for these facilities and reduce waste disposal costs.

Considerations:

- **Cost:** Forestry residues are more expensive than other SAF eligible waste resources (MSW, agricultural waste) due to logistical challenges in collecting and transporting bulky, low-density materials. For example, processing beetle-killed lodgepole pine requires felling, chipping, drying, and transport to centralized facilities. Optimizing logistics and storage systems is essential for cost reduction and supply chain efficiency.
- **Conversion Challenges:** Woody biomass consists of complex polymers like lignin and cellulose, which require specialized and costly pretreatment for biofuel production. While enzymatic conversion of sugars to ethanol can reach 90% efficiency, cellulose-to-ethanol conversion remains lower at approximately 40%. A 2024 study by Concawe and Aramco found that cellulosic ethanol costs 1.5 to 2.5 times more than crop-based ethanol.
- **Multiple Stakeholders Engagement:** Colorado's forests are managed by various public and private entities, including federal agencies, private landowners, tribal governments, and municipalities. Effective forestry residue utilization will require strong coordination among these diverse stakeholders.
- **Policy:** Financial incentives will be essential to achieving economic viability. The current inability to generate Renewable Identification Number (RIN) credits from forestry residues harvested from federal lands adversely impacts the financial outlook for SAF refineries.
- **Feedstock Competition:** Forestry residues are burned to generate energy, as was done at the now closed Eagle Valley Clean Energy Biomass Plant in Gypsum. In 2023, Xcel Energy announced plans to build a 19 MW biomass plant on the site of their coal powered Hayden Generating Sation due to close in 2028. A policy-level determination is required to assess whether the societal benefits are greater when forestry residues are utilized for SAF production versus energy generation.
- **Commercial Viability:** The technologies for converting forestry residues into SAF have not yet been proven at commercial scale. A comprehensive techno-economic analysis will be necessary to establish commercial feasibility and mitigate investment risk.

3.6.4 Conclusions and Key Findings

Despite several challenges, forestry residues present significant potential as a SAF feedstock. The Western Slope possesses a uniquely abundant supply of forestry resources, giving Colorado a competitive advantage over regions with fewer forest assets. Beyond environmental benefits such as wildfire management, utilizing forestry residues for SAF production can create economic opportunities and help revitalize Colorado's forestry industry, which has been in decline since the 1990s due to market shifts, environmental concerns, federal policies, pest epidemics, droughts, and wildfires. Additionally, unlike other SAF feedstocks, forestry residues offer four distinct conversion pathways, enhancing versatility and adaptability.

To fully realize this potential, strategic coordination is essential. Engaging with state and county officials will help determine whether SAF production or energy generation should be prioritized, as pursuing both simultaneously may not be economically viable. Gathering detailed data from Western Slope wood processing facilities will clarify available SFR quantities. Discussions with Velocys could explore interest in developing a SAF production facility, while potential synergies with Charm Industrial should also be assessed. Furthermore, evaluating the feasibility of blending forestry residues with municipal solid waste and agricultural residues will require expert input from the gasification industry. Targeted collaboration across these areas will be key to optimizing forestry residue utilization and advancing Colorado’s leadership in SAF production.

3.7 Municipal solid waste - Overview

MSW represents a highly abundant and largely underutilized feedstock for SAF production in the Western Slope region of Colorado. Two primary forms of MSW-derived feedstocks have been identified as viable for SAF pathways: the organic fraction of MSW (OFMSW) and landfill gas (LFG), both of which offer significant conversion potential through gasification, Fischer-Tropsch synthesis, Alcohol to Jet Fuel, pyrolysis, and power-to-liquid technologies (Bio98 Paper).

Organic fraction of MSW – OF-MSW

The significance of OF-MSW lies in its constant generation rate and relatively high carbon content. When processed through gasification or hydrothermal liquefaction, the OF-MSW undergoes a series of preparatory steps including sorting, shredding to a uniform size, and drying, before it is transformed into syngas or bio-crude oil, which can be subsequently upgraded into SAF via Fischer-Tropsch synthesis (ICAO, 2024). Pilot studies and commercial models in Europe and California support the technical and economic feasibility of this pathway, contingent upon reliable sorting systems and pre-processing infrastructure (BP, 2024).

Landfill gas - LFG

Landfill gas, primarily composed of methane (CH_4) and carbon dioxide (CO_2), arises from the anaerobic decomposition of organic materials in landfills. In the Western Slope, LFG capture systems are currently in place at select facilities, such as the Mesa County Landfill, which has been evaluating methane recovery for energy use under regional sustainability mandates

(Task 1 Report, p. 8). An estimated 50,000 to 100,000 metric tons of CO_2-equivalent emissions from landfill gas could be captured annually in this region (Bio98 Paper). Currently, LFG is not being collected in landfills within the Western Slope.

In Western Colorado, waste collection and landfill management are decentralized, with each county maintaining its own operations. Participating entities managing MSW include the Mesa County Landfill in Grand Junction, the fraction of MSW that Bruin Waste collects from Mesa County and diverts to the Broad Canyon Landfill, Eagle County Landfill in Eagle, Abode Buttes Landfill in Delta County, and Pitkin County Landfill in Aspen (Task 1 Report, p. 8). These facilities serve as central collection hubs for residential and commercial waste, and could be positioned to play a strategic role in future SAF feedstock supply chains.

MSW can be converted to biofuel via four pathways that convert the feedstock to biocrude, which is then refined into jet fuel.

- Fischer-Tropsch Gasification (FT).
- Alcohol-to-Jet (AtJ).
- Power-to-Liquid (PtL)
- Pyrolysis.

All four pathways can use a mix of feedstocks in addition to MSW, such as forestry and agricultural residues. The FT and AtJ processes are certified pathways to produce SAF while pyrolysis and PtL are undergoing the certification process. The volumes of MSW needed to supply an MSW-to-SAF refinery are estimated using the example of the Fulcrum BioEnergy plant built in Nevada and ICAO's 'Rules of Thumb,' a set of simplified estimations used to assess SAF costs, investment needs, and production potential:

Table 30 - MSW MT needed to Operate an MSW-to-SAF FT Commercial Refinery

Operator	Plant Capacity MT/Yr	MSW MT/Yr	SAF Output MT/Yr
Fulcrum	n/a	219,000	32,592
RoT – nth plant	388,000	1,251,613	155,200
RoT – pioneer plant	77,600	250,322	31,040

Source: Savia Consulting using data from Fulcrum (C&EN) and the ICAO SAF Rules of Thumb. Note that only the density of SAF is used for unit conversion purposes for RoT.

3.7.1 Sustainability Analysis

MSW as a feedstock for SAF aligns well with key ICAO CORSIA sustainability criteria:

- **GHG Reduction:** MSW-derived SAF pathways have demonstrated lifecycle greenhouse gas (GHG) emission reductions of over 70% compared to conventional jet fuel. Plastics are not approved by ICAO for SAF production nor for claiming emissions reduction under CORSIA. In the U.S., MSW plastics aren't fully banned but must be limited, as they may disqualify fuel from state and federal credits.

- **Land Use and Food Security**: As a waste-based feedstock, MSW does not require additional land or compete with food production, avoiding indirect land use change (ILUC) concerns.
- **Water and Soil Impact:** Utilizing MSW avoids the need for irrigation or agricultural inputs, minimizing impacts on water and soil resources.
- **Certification Readiness:** FT and ATJ MSW-to-SAF pathways have been recognized under major sustainability certification schemes, including RSB and ISCC. Pyrolysis and MtJ are in the process of being certified.

The following table shows the default core LCA value for SAF derived from MSW for the FT pathway with varying percentages of non-biogenic (NBC) content, which includes plastics and rubber:

Table 31 - LCA results for MSW [gCO2e /MJ]

Feedstock	Data Provider	Model	Non-biogenic carbon (NBC) content	MSW transportation	MSW rejects transportation	Feedstock-to-fuel conversion	Fuel transportation	Fuel combustion	Total	Midpoint value
MSW	MIT	GREET lifecycle inventory (Suresh, 2016)	NBC ≤ 5%	3.9	0.4	2.5	0.9	1.8	**9.5**	NBC*170.5+5.2
			5% < NBC ≤ 10%	3.9	0.4	7.3	0.9	5.5	**18**	
			10% < NBC ≤ 15%	3.9	0.4	12.1	0.9	9.2	**26.5**	
			15% < NBC ≤ 20%	3.9	0.4	16.9	0.9	12.9	**35**	
			20% < NBC ≤ 25%	3.9	0.4	21.9	0.9	16.6	**43.6**	
			25% < NBC ≤ 30%	3.9	0.4	26.7	0.9	20.2	**52.1**	
			30% < NBC ≤ 35%	3.9	0.4	31.5	0.9	23.9	**60.6**	
			35% < NBC ≤ 40%	3.9	0.4	36.3	0.9	27.6	**69.1**	
			40% < NBC ≤ 45%	3.9	0.4	41.2	0.9	31.3	**77.7**	
			45% < NBC ≤ 50%	3.9	0.4	46.1	0.9	34.9	**86.2**	

Source: CORSIA supporting document — Life cycle assessment methodology

3.7.2 Feedstock Analysis

Regardless of conversion pathway, the viability of MSW as a feedstock is also shaped by local regulatory conditions and landfill diversion goals. Colorado's statewide initiatives to increase recycling and composting rates intersect with SAF feedstock development, as both efforts benefit from improved waste separation and organic fraction recovery. Moreover, the 2023 adoption of Extended Producer Responsibility (EPR) legislation in Colorado signals a policy shift toward circular resource utilization, which could further facilitate MSW-to-fuel pathways (CDPHE, 2023).

In 2023, the state of Colorado generated an estimated 6.4 pounds of MSW per person per day—equivalent to approximately 2.3 tons per person annually. Entities like Waste Management and Republic Services operate in many of these counties, providing waste collection, sorting, and transfer services that could be adapted to support OFMSW recovery at scale (Bio98 Paper). Higher concentrations of food waste in the MSW stream lead to improved yields, as food waste is more readily broken down compared to other materials such as wood, paper, cardboard, or yard trimmings.

The cities of Grand Junction, Glenwood Springs, Aspen, Delta, and Montrose, along with associated rural areas, produce MSW volumes that collectively contribute to this statewide estimate, none of them segregate the OFMSW.

Figure 14 - Mesa County Landfill

Source: Picture taken during on-site visit

Data obtained through on-site visits, conversations, and email exchanges with personnel and relevant stakeholders indicate the following available volumes of MSW per selected county, 57% makes up for the organic fraction:

Table 32 - Western Slope Landfill Volumes

LANDFILL	MSW (MT)	OFMSW (MT)
Eagle County	117,000	66,690
Mesa County	140,000	79,800
Broad Canyon Landfill (Mesa)	60,000	34,200
Montrose County	120,000	68,400
Abode Buttes Landfill (Delta)	35,300	20,100
Pitkin Landfill County	62,000	35,340
Totals	**534,300**	**304,530**

Source: Savia Consulting

According to calculated volumes of MSW needed for a SAF refinery reflected in the above Table 30, none of the evaluated counties process enough MSW to feed an economically viable SAF refinery. The opportunity seems to lie in centralizing the management of the OFMSW from all counties; it is adamant for all landfills to pre-sort the organic fraction of the total volumes of MSW received, a practice currently not being implemented. The resulting aggregated

304,503 MT of OFMSW would outpace the volumes needed for a pioneer type plant (Fulcrum), potentially offering the opportunity for expansion of the SAF refinery as MSW volumes increase with population growth. The table below compares the Western Slope's aggregated OFMSW with the annual feedstock needs of a pioneer-scale MSW-to-FT SAF facility, providing a clear assessment of supply adequacy and potential excess capacity.

Table 33 – Organic Fraction of MSW Supply vs FT Pioneer-Scale Requirement - Western Slope

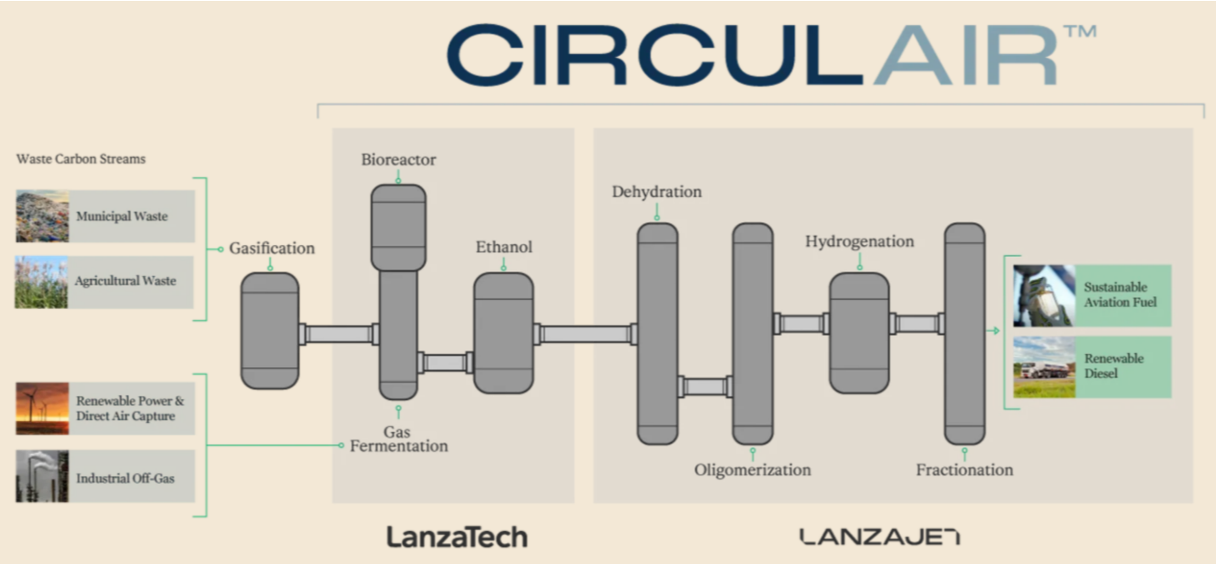
ICAO RoT - FT Pioneer Plant	MT/year
Total OFMSW Aggregated (Delta, Eagle, Pitkin, Mesa, Montrose)	304,530
FT Pioneer-Scale Feedstock Requirement	250,000
Surplus OFMSW Available	**54,530**
% of Requirement Met	**122%**

Source: Savia Consulting

It is worth noting that SynTech Bioenergy LLC, headquartered in Englewood, Colorado, has proposed the construction of a processing facility that would use Eagle County landfill's MSW to produce SAF via FT process. The project, estimated at $117 million, has been planned to become operational as early as 2026. However, the confidential nature of the proposal did not allow Eagle County to share specific details regarding the plant's processing capacity, required feedstock volumes, or economic viability. Based on available information, the facility appears to be of a much smaller scale than the plants evaluated in this report.

If the centralization of the OFMSW from multiple landfills is not feasible, a comprehensive analysis is warranted to evaluate the feasibility of co-processing MSW from one landfill with other biomass feedstocks, such as forestry and agricultural residues. Several companies, including LanzaJet through its CIRCULAIR initiative, is currently developing multi-feedstock conversion technologies for SAF production; the proposed CIRCULAIR process is illustrated on the following figure:

Figure 15 – LanzaJet's multi-feedstock SAF conversion process



Source: LanzaJet

3.7.3 Opportunities and Considerations

The potential for MSW as a SAF feedstock in Western Colorado is shaped by a combination of logistical advantages, policy incentives, and technical challenges. With an annual MSW generation of 534,300 metric tons across the six selected landfills, the OFMSW accounts for 57% of this total, providing a substantial resource for SAF production. While the presence of established waste collection infrastructure and supportive policies create a favorable landscape for SAF development, significant hurdles related to waste separation, competing landfill management priorities, and commercial feasibility must be addressed. The following section outlines the opportunities and constraints associated with leveraging MSW for SAF production.

Opportunities:

- Existing waste collection infrastructure allows for logistical coordination, with potential to aggregate OFMSW from multiple landfills into a centralized processing facility.
- If centralized, the OFMSW generation levels indicate sufficient feedstock supply for a pioneer-scale SAF facility, with volumes exceeding the estimated minimum requirement for an MSW-to-SAF refinery.
- Colorado's policy landscape, including EPR legislation and upcoming landfill methane regulations, creates favorable conditions for MSW-based SAF production.
- Strengthening collaboration with key stakeholders, including SynTech Bioenergy (Eagle County), Waste Management, Republic Services, and landfill operators such as Mesa County Landfill and Eagle County Landfill, can improve logistical coordination and enhance the economic feasibility of MSW-to-SAF processing.

Considerations:

- No current pre-sorting of OFMSW occurs at landfills, requiring investment in separation infrastructure to improve feedstock purity and conversion efficiency.
- The lack of a centralized processing facility for OFMSW across the study area complicates feedstock aggregation, requiring coordinated waste segregation and transport logistics to ensure a stable and scalable SAF supply.
- Past MSW-to-SAF projects (Fulcrum BioEnergy, Enerkem) have faced technical and financial challenges, underscoring the need for detailed feasibility analysis.
- Commercial viability remains uncertain due to infrastructure costs, market stability, and regulatory compliance requirements, necessitating strong financial modeling and risk mitigation strategies.

3.7.4 Conclusion and Key Findings

MSW is one of the most readily available but underutilized SAF feedstocks in Western Colorado. With six major landfills generating over 534,300 metric tons (MT) of waste annually, the organic fraction (304,530 MT) presents a viable opportunity for SAF conversion through the FT pathway.

However, MSW-to-SAF viability depends on feedstock consistency, infrastructure investment, and long-term economic feasibility. The absence of pre-sorting for OFMSW, combined with decentralized landfill management, limits scalability and conversion efficiency. No individual landfill—Mesa County, Eagle County, Delta, or Pitkin County—can sustain a commercial SAF refinery without feedstock aggregation or supplemental biomass inputs.

To improve readiness, coordinated waste separation protocols and cross-county partnerships for the centralized management of the FOMSW of the evaluated counties should be prioritized. Stakeholder engagement with SynTech Bioenergy, LanzaJet, landfill operators, and waste management firms is essential to refine logistics, economic feasibility, and multi-feedstock blending models. Additionally, Colorado's evolving waste policies, including the EPR legislation and methane mitigation regulations, create a regulatory framework conducive to MSW valorization.

> **Case Study: Early Commercialization Attempts of MSW-to-SAF**
>
> Fulcrum BioEnergy, located in Reno, Nevada, was the first commercial MSW to SAF plant using FT Gasification but ceased operations in 2024 due to technical issues and financial losses. Their planned project in northwestern England, with a slated capacity of 100 million liters per year of SAF once it begins operations in 2027, is now in doubt. A proposed facility in Gary, Indiana, was ultimately shelved due to significant local opposition
>
> Enerkem's MSW-to ethanol plant in Edmonton, Canada ceased operations after only 14 years, falling short of its intended 25-year operational lifespan. The company has since entered receivership and terminated projects in both Canada and Spain.
>
> LanzaJet's ATJ SAF plant in Soperton, Georgia, began commercial-scale production in Q4 2025. The technology can incorporate ethanol produced from a range of feedstocks, including MSW, agricultural residues, and industrial gases. Public reporting indicates that ethanol used in the initial commercial deployment was produced from corn and sugarcane bagasse. ATJ technology maturity remains concentrated at early commercial and demonstration scale.

Aggregating OFMSW from multiple landfills seems the most viable path to achieving feedstock volume for SAF production. Establishing a centralized processing hub and implementing pre-sorting measures would enhance feedstock consistency and efficiency. Integrating complementary biomass sources, such as forestry residues, agricultural waste, and wastewater-derived biogas, could further optimize SAF yield. Pilot-scale processing, technology validation, and public-private investment are essential to realizing OFMSW's full potential in Western Colorado's SAF supply chain.

3.8 Wastewater - Overview

Municipal wastewater can serve as a SAF feedstock by recovering organic sludge and biogas from treatment facilities. During processing, raw sewage from residential and commercial sources is separated into liquid and solid components. The solid fraction, known as sludge or biosolids, contains high organic content along with contaminants and essential nutrients such as nitrogen and phosphorus.

In the United States, sewage sludge is typically managed through one of four disposal methods:

1. Utilized as a compost and fertilizer in agricultural applications,
2. Directed to landfills,
3. Incinerated, or
4. Treated with chemicals to neutralize contaminants and improve safety for reuse

Each of these options presents potential environmental challenges. This has prompted ongoing research into more sustainable alternatives, such as converting the sludge into renewable fuels, including renewable natural gas (RNG) and SAF.

Before it is refined into SAF, sewage may be converted to biocrude oil using the Hydrothermal Liquefaction (HTL) process, or to biogas via anaerobic digestion. Both conversion processes have yet to receive qualification under ASTM standards.

This section uses data and information obtained from online meetings with the Persigo Wastewater treatment plant in Grand Junction, Clifton Sanitation, and publicly available reports and data to determine whether the Western Slope generates enough sewage to supply a SAF facility.

3.8.1 Sustainability Analysis

Wastewater aligns well with ICAO CORSIA sustainability criteria:

- **GHG Reduction:** Biofuels derived from wastewater can achieve lifecycle greenhouse gas (GHG) emission reductions exceeding 60%, contributing significantly to decarbonization goals.
- **Air:** The use of wastewater sludge for SAF production helps mitigate air pollution from incineration and agricultural applications.

- **Land Use and Food Security:** Utilizing biosolids does not require additional land or interfere with food production.
- **Water and Soil Impact:** By repurposing wastewater for SAF production, jurisdictions can prevent the risks of exposure to harmful pathogens, heavy metals, and industrial chemicals, avoiding long-term environmental degradation of soil and water.
- **Certification Readiness***:* Wastewater sludge may be eligible for certification under CORSIA if it meets the criteria for waste, residues, or by-products as defined by ICAO. As stated above, the ISCC CORSIA framework includes waste and processing residues in its certification process. Nevertheless, to date, wastewater sludge is not in ICAO's list of recognized feedstocks for SAF production. However, they have not been certified for use as aviation fuel.

3.8.2 Feedstock Analysis

Biocude. Firefly Green Fuels is establishing the world's first sewage-to-SAF plant at the Haltermann Carless refinery in Harwich, Essex. It has partnered with Anglian Water, which produces 380,000 tons of biosolids annually, to supply sewage sludge. Anglian Water serves an area of 27,500 square kilometers—about 20% of England and Wales—far larger than the Western Slope and Colorado, with a much higher population density.

A comparison of wastewater biosolid output from the Persigo and Clifton Water Treatment Plants with Firefly Green Fuels' announced plans shows that the available feedstock is insufficient to support an SAF facility of this scale, illustrated in the following table:

Table 34 - Wastewater Biosolids and SAF output

Operator	Wastewater Biosolids MT/Yr	Potential SAF Output MT/Yr
Firefly Green Fuels	1,000,000	43,000
Persigo Wastewater Treatment	5,500	239
Clifton Sanitation	913	40

Source: Savia Consulting using data from AIN Media, Firefly Green Fuels and interviews with Persio and Clifton water treatment plants

Biogas. Clifton Sanitation's wastewater treatment process does not produce biogas. The Persigo Water Treatment Plant makes RNG from the biogas produced under anaerobic digestion and use it to fuel public transport fleets. From an energy and economic standpoint, Persigo is making the most efficient use of the biogas it generates.

3.8.3 Opportunities and Considerations

Significant barriers must be addressed before wastewater can be considered a viable option for the Western Slope.

- **Logistical and Supply Constraints:** Similar to the case with MSW, wastewater sludge faces substantial supply chain challenges. Treatment facilities are widely dispersed and

SUSTAINABLE AVIATION

vary in their operational processes, making centralized collection and processing impractical. Furthermore, due to the extremely low yield of sludge, even a coordinated effort across all regional wastewater treatment plants would fail to generate sufficient volume to support a SAF facility. This approach is far better suited to densely populated metropolitan areas than to the more sparsely populated Western Slope.

- **Feedstock Competition:** As demonstrated by the innovative Persigo Water Treatment Plant, wastewater sludge can be effectively utilized for RNG production, which is used to fuel approximately 40 fleet vehicles, including garbage trucks and street sweepers. This method offers a more cost-effective, technologically advanced, and commercially viable alternative to SAF production.
- **Technological Maturity:** Current conversion technologies for wastewater sludge are still years away from achieving commercial-scale viability, posing an additional challenge to implementation in the region.
- **Eligibility:** yet to become a qualified SAF conversion pathway and for use in aircraft and to be incorporated into ICAO's list of approved feedstocks for SAF production.

3.8.4 Conclusions and Key Findings

While wastewater offers several appealing attributes—such as low cost and ongoing availability—it is not currently a viable SAF feedstock for the Western Slope. Key limitations include insufficient local volume, geographically dispersed treatment facilities, competition from existing RNG applications, and the high investment risk associated with an unproven and uncertified conversion technology.

3.9 Industrial Gases - Overview

Several industrial sectors—including steel and metal production, cement manufacturing, power generation, and oil refining—emit substantial quantities of carbon dioxide (CO_2) and other gases as by-products. These emissions are released into the atmosphere via smokestacks, contributing to global climate change and degrading local air quality.

However, industrial gases possess high carbon content, making them a valuable feedstock for renewable fuel production when appropriately captured and converted into SAF. This process of carbon recycling addresses two critical challenges simultaneously: it mitigates point-source emissions and supplies renewable fuel for the aviation sector, which remains one of the most challenging industries to decarbonize.

Key industrial sectors contributing to CO_2 emissions include cement manufacturing, petroleum refining, and metal processing. Cement plants in the region, such as the Holcim Cement Plant in Florence, Colorado, release significant CO_2 through limestone calcination and fuel combustion (IGES). Additionally, petroleum refining facilities and natural gas processing plants contribute to CO_2 emissions, particularly in areas with active fossil fuel extraction (IEA).

The objective of this section is to determine whether the Western Slope possesses the necessary inputs for a SAF plant made from industrial gas using information obtained in on-line meetings with the Colorado Energy Office, PtL Technology providers, and publicly available information from sources such as Project SkyPower and the Colorado Department of Health & Environment's Colorado Greenhouse Gas Inventory.

3.9.1 Applicable Conversion Technologies and Required inputs

Industrial gases serve as critical feedstocks in the well-established Fischer-Tropsch process. The production of power-to-liquid (PtL) synthetic aviation fuel—commonly referred to as e-SAF—requires three essential inputs:

Carbon Dioxide (CO_2): This can be sourced from industrial emitters such as steel mills or cement factories through a method known as point source capture. Alternatively, CO_2 may be extracted directly from the atmosphere via Direct Air Capture (DAC). However, DAC yields significantly lower CO_2 concentrations—approximately 0.04% (400 ppm)—compared to point source capture, which typically captures CO_2 at concentrations of 8–10%. As a result, DAC is substantially more costly.

Renewable Electricity: Derived from sustainable sources such as solar, wind, or hydroelectric power, renewable electricity is a foundational component in the hydrogen production process.

Case Study: US PtL Projects

Using industrial gases to produce fuel is at a very high TRL level, since the process is commercially proven using coal (CTL) and natural gas (GTL). CTL was approved by ASTM in 1999 and is produced by SASOL in South Africa. There are two large GTL plants in operation, one in Qatar and the other in Uzbekistan. In the US, PtL SAF projects using industrial gas are progressing rapidly but have stalled in the EU due to problems obtaining Front End Engineering FEED study financing.

- Twelve is building a 50 000 gallon per year commercial plant in Moses Lake Washington called AirplantOne that is supposed to start operating in 2025.

- Infinium just announced that they have started building its second U.S.-based production site, known as Project Roadrunner near Pecos Texas capable of producing 7.6 million gallons per year of efuels, including eSAF. They operate a center of excellence facility in Corpus Christi, Texas called Project Pathfinder.

- In Europe, mandates have spurred a lot of activity with 45 announced projects. However, only one, Arkadia eFuels, has reached a final investment decision.

Green Hydrogen: Produced through water electrolysis powered by renewable energy, green hydrogen is another key input.

3.9.2 Sustainability Analysis

Power-to-Liquid SAF performs strongly across key ICAO CORSIA sustainability criteria:

- **GHG Reduction:** PtL SAF can achieve lifecycle GHG emission reductions of over 90% when produced using renewable electricity and captured CO_2. In regions like Colorado, where the energy mix includes a relatively low proportion of renewable energy such as hydroelectric, solar, or wind power, the carbon intensity (CI) advantage is reduced.
- **Land Use and Food Security:** PtL production does not require arable land, eliminating competition with food crops and avoiding indirect land use change (ILUC).
- **Water and Soil Impact:** The PtL process has minimal impact on soil resources, as it is an industrial process that does not rely on agricultural inputs or freshwater-intensive cultivation. However, the electrolysis process, which is commonly used to produce hydrogen, demands very large volumes of water — a significant drawback in areas experiencing water scarcity.
- **Certification Readiness:** PtL pathways are recognized by certification bodies such as RSB and ISCC, with early projects demonstrating alignment with stringent sustainability criteria.

ICAO has not published a core default value for PtL SAF. However, a study from the German Environment Agency estimates a CI of 5-10 g CO_2e/MJ which is very low.

Table 35 - CI of PTL SAF made from industrial gas

Feedstock (pathway)	GHG emissions without LUC ($g_{CO_2eq}/MJ_{jet fuel}$)	GHG emissions incl. LUC ($g_{CO_2eq}/MJ_{jet fuel}$)	Reference
Jatropha oil (HEFA)	40.0	13 – 141[1]	(Kolosz et al. 2020)
Rapeseed oil (HEFA)	46.6	69.6[2]	(Zhao et al. 2021; Prussi et al. 2021; ICAO 2021a)
Soybean oil (HEFA)	39.7	61.8[2]	(Zhao et al. 2021; Prussi et al. 2021; ICAO 2021a)
Palm oil, open pond (HEFA)	57.8	96.8[2]	(Zhao et al. 2021; Prussi et al. 2021; ICAO 2021a)
Palm oil, closed pond (HEFA)	37.4	76.5[2]	(Prussi et al. 2021; ICAO 2021a)
Palm oil (HEFA)	51.9 – 94.5	57.1 – 126.7[1]	(O'Connell et al. 2019)
Bioethanol from sugar cane (AtJ)	24.1	33.1[2]	(Prussi et al. 2021)
Bioethanol from sugar beet (AtJ)	50.9		(Moretti et al. 2021)
Bioethanol from maize (AtJ)	65.7	90.7[2]	(Prussi et al. 2021)
Miscanthus (BtL)	10.4	-11.6[1]	(ICAO 2021a)
Poplar (BtL)	9.0		(Jong et al. 2017)
PtG LH_2	4 – 9	n. a.	LBST, this study
PtL	5 – 10	n. a.	LBST, this study
Crude oil	89.0		(ICAO 2021b)
Natural gas (GtL)	91.0		(Wong 2008)

Source: German Environment Agency

3.9.3 Feedstock Analysis

The following table shows the amount of CO_2 needed from two planned pioneer plants in Denmark and France. The CO_2 requirements for the Twelve and Infinium plants in the US are not publicly available. For unknown reasons ICAO RoT only provides conversion factors for an nth plant, not a pioneer facility.

Table 36 - CO_2 needed to operate a PtL -SAF Commercial Refinery

Operator	Plant Capacity MT/Yr	CO2 MT/Yr	SAF Output MT/Yr
Arkadia	n/a	260.000	68,000
SAF+IG	n/a	280,000	76,000
RoT – nth plant	776,000	3,233,333	155.200

Source: Savia Consulting using data from the SASHA Coalition and Arkadia , SAF+IG proprietary information, ICAO SAF Rules of Thumb. Note that only the density of SAF is used for unit conversion purposes for RoT.

CO_2 Supply: A pioneer eSAF refinery needs a steady supply of over 260,000 tons of CO_2 annually. While Colorado has multiple large emitters as per CDPHE and EPA data, as shown in the table and map below, none are in the Western Slope. The only facilities that provide enough CO_2 are coal burning power stations, the Suncor refinery, food companies such as Molson Coors and cement manufacturers. They are all located outside the Delta, Montrose, Pitkin. The largest GHG emitters in these counties are landfills and they produce methane, not carbon dioxide.

CO_2 pipelines, such as the Kinder Morgan Cortez Pipeline (1.5 billion cubic feet/day capacity), pass through the region but are currently dedicated to enhanced oil recovery (EOR) in the Permian Basin, making them unavailable for refinery use. In addition, it is not considered to be biogenic so it would not help reduce the CI of the SAF.

The table below is a screenshot of a list ranking Colorado's largest emitters from Colorado's Facility GHG Reporting website. Consulting the list confirms that there are no installations in the counties in this study that come close to being able to provide the required amount of CO_2 needed to supply a pioneer eSAF plant, never mind a nth plant.

Table 37 – Biggest GHG emitters in Colorado

Sector	Power Plants	Petroleum and Natural Gas Systems	Refineries	Chemicals	Other	Minerals	Waste	Metals	Pulp and Paper	Total Reported Emissions What's this?
2023 GHG Emissions (Million Metric Tons CO_2e)	28	4.2	0.6	0.3	1.3	1.9	1.1	0.3	0	38
# of Reporting Facilities	26	40	1	4	21	7	23	2	0	121

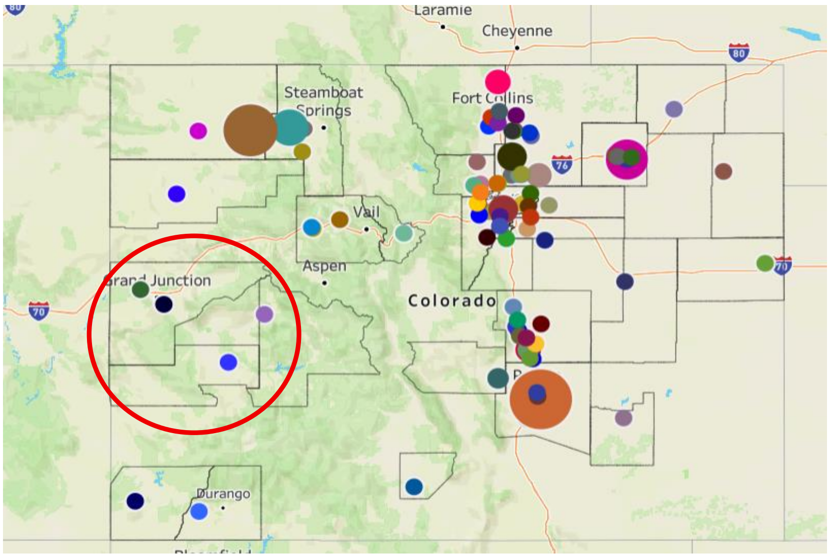
2023 – Colorado – Total Reported Emissions by Facility in Metric Tons of CO_2e

Facility	City	State	Total Reported Emissions	Sectors
Comanche (470)	PUEBLO	CO	6,956,536	Power Plants
Craig	CRAIG	CO	5,280,237	Power Plants
Pawnee	Brush	CO	3,084,539	Power Plants
Hayden	HAYDEN	CO	2,655,236	Power Plants
Antero Midstream LLC- 160A Basin	Denver	CO	1,893,530	Petroleum and Natural Gas Systems
Fort St. Vrain	PLATTEVILLE	CO	1,672,320	Power Plants
Cherokee	DENVER	CO	1,513,520	Power Plants
DCP Midstream 430 Permian Basin	Denver	CO	1,473,324	Petroleum and Natural Gas Systems
Rawhide Energy Station	Wellington	CO	1,444,628	Power Plants
DCP Midstream 360 Anadarko Basin	Denver	CO	1,241,355	Petroleum and Natural Gas Systems
Rocky Mountain Energy Center	KEENESBURG	CO	1,073,837	Power Plants
Ray D Nixon	FOUNTAIN	CO	1,064,192	Power Plants
580 San Juan Basin – Simcoe LLC	DURANGO	CO	969,862	Petroleum and Natural Gas Systems
(540) Civitas Resources – Denver Basin	Denver	CO	887,160	Petroleum and Natural Gas Systems
Uinta Basin – Caerus Uintah	Denver	CO	885,431	Petroleum and Natural Gas Systems
Front Range Power Plant	FOUNTAIN	CO	870,408	Power Plants

Source: Colorado Department of Public Health and Environment

The following figure shows the distribution of Colorado's biggest GHG emitters, including CO_2, according to the Colorado Facility Reported GHG Explorer. Emissions quantity is proportional to the diameter of the circles. The figure shows that the biggest emitters and candidates for a PtL plant according to feedstock volumes needed are outside of the Western Slope.

Figure 16 - Graphical representation of the Colorado's GHG Emitters



Source: Colorado Department of Public Health and Environment

In addition to CO_2 supply, establishing an eSAF refinery in Colorado's Western Slope requires evaluating other key inputs: hydrogen availability, water resources, and electricity costs.

Hydrogen. Producing eSAF requires 0.4 tons of hydrogen per ton of fuel, or about 40 000 tons per year for a commercial sized plant. Such facilities are typically co-located with hydrogen hubs. Colorado's exclusion from the federally supported Western Inter-States Hydrogen Hub limits the feasibility of local hydrogen supply for a refinery.

Water. Electrolytic hydrogen production consumes 9–11 liters (2.4-2.9 gallons) of water per kilogram of hydrogen. The Western Slope faces chronic water scarcity, especially for agriculture, making large-scale industrial use environmentally and socially unsustainable.

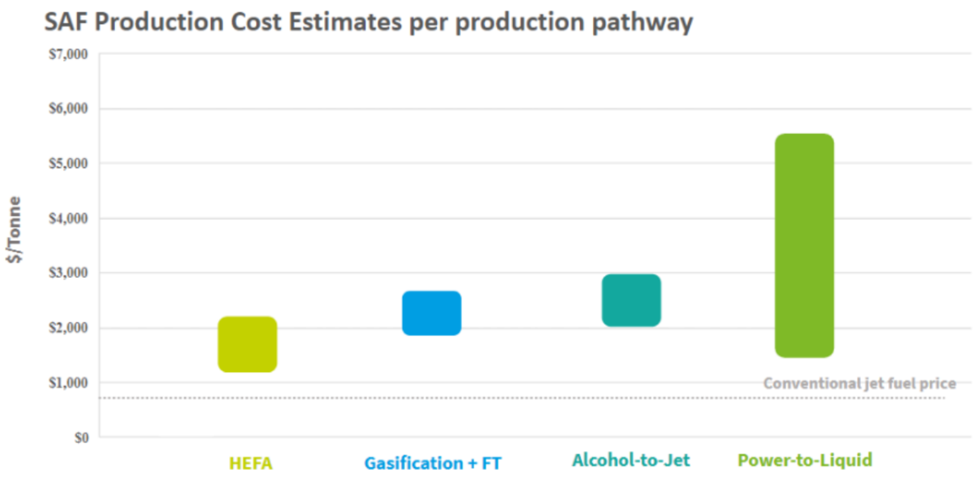
Electricity. Electrolysis demands about 300 megawatts of renewable energy and is the largest operating cost driver. It is estimated that a price of 6–8 cents/kWh is needed for commercial viability. Colorado's average cost (~15 cents/kWh) is low for the US but still too high for an eSAF plant. Additionally, only 39% of the state's electricity was renewable in 2023, falling short of the low-carbon benchmarks seen in France (94%) or Quebec (99%).

3.9.4 Opportunities and Considerations

While SAF derived from industrial gas (eSAF) is regarded as one of the most promising feedstock options for the future in Europe, the advancement of this technology in the Western Slope region encounters several significant challenges:

- Insufficient availability of key inputs, including carbon dioxide (CO_2), water, and hydrogen.
- Elevated electricity costs coupled with a limited share of renewable energy in the regional energy mix.
- Absence of supportive policy mechanisms or incentives to close the cost gap between eSAF and alternative SAF pathways. Airlines will prefer to buy less expensive SAF made from other feedstocks.

Figure 17- SAF Production Costs Per Production Pathway



Source: CZAdvise

3.9.5 Conclusions and Key Findings

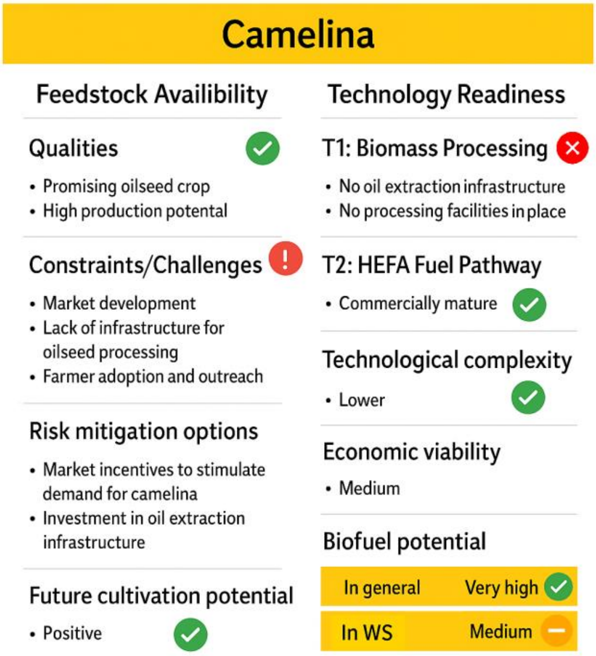
Based on current conditions, using industrial gases (e.g., CO_2) as a feedstock for a SAF refinery in Colorado's Western Slope is not viable. Key barriers include:

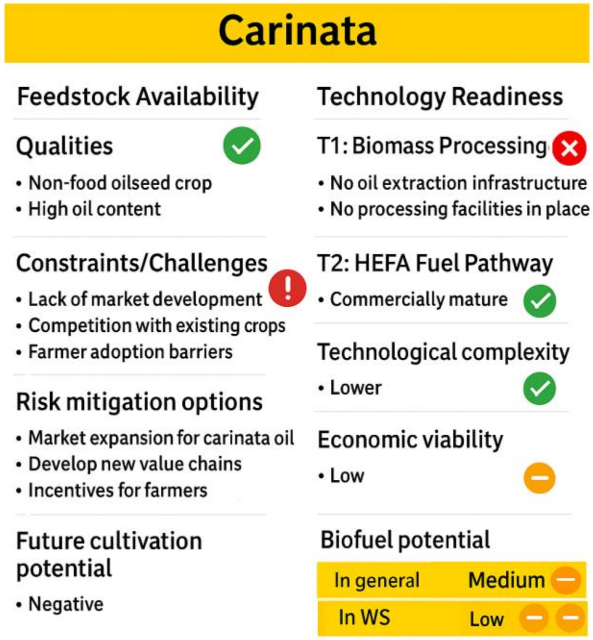
- **Insufficient access to concentrated CO_2 sources** within the region.
- **Lack of water resources** needed for electrolysis-based hydrogen production.
- **High electricity costs** and a relatively low share of renewables in the local grid.
- **Absence of policy support or economic incentives**, which are essential given that eSAF production remains significantly more expensive than other SAF pathways.

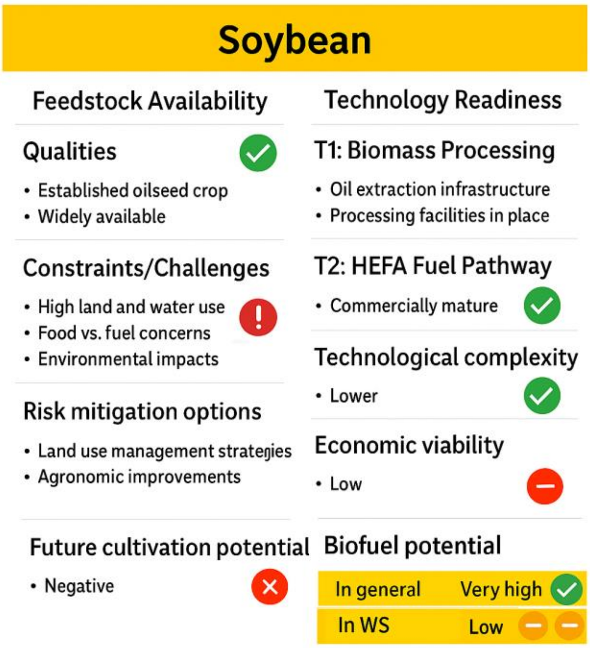
Without federal or state-level measures to close the cost gap, it will be extremely challenging to secure investment or long-term offtake agreements. While eSAF technology holds long-term promise—especially in regions with abundant low-cost, low-carbon energy—the Western Slope is not currently positioned to support its development. Alternative feedstocks, such as municipal solid waste, agricultural residues, or forestry biomass, offer more realistic and cost-effective pathways for SAF production in this region.

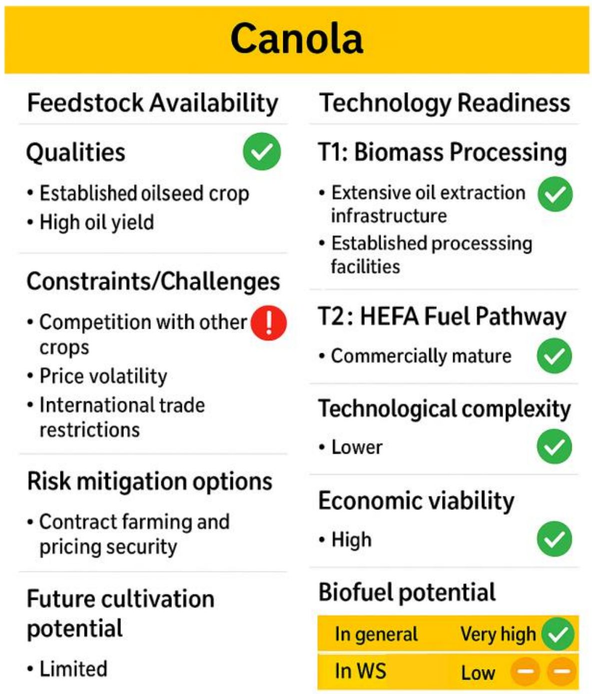
4. Feasibility Matrices – Featured Feedstocks

This section provides a graphical synopsis in the form of a 'Feasibility Matrix' which summarizes the information obtained in section 3 of this report. A matrix is provided for those feedstocks identified as offering available or potentially available volumes for SAF processing. Each one illustrates opportunities and major constraints with regard to the maturity of the featured feedstock's supply chain, as well as the feasibility of the entire supply chain (e.g. spatial quantification of feedstock densities for qualifying feedstock like forest residues), including available technology options.









MSW

Feedstock Availability

Qualities
- Abundant supply
- Low-cost feedstock

Constraints/Challenges
- Heterogeneous composition
- High moisture content
- No sorting of OFMSW

Risk mitigation options
- Improved sorting and separation technologies
- Pre-treatment to reduce moisture

Future feedstock potential
- Positive w/centralization of OFMSW

Technology Readiness

T1: Biomass Processing
- Established engineered landfills
- No sorting of OFMSW

T2: FT, AtJ, MtJ and pyrolysis
- Commercially immature

Technological complexity
- Medium

Economic viability
- Medium

Biofuel potential

In general	Moderate
In WS	Moderate

Forestry Residues

Feedstock Availability

Qualities
- Low market value
- High volumes available

Constraints/Challenges
- Decentralized locations
- Collection neglected
- Environmental impacts

Risk mitigation options
- Better residue management
- Improved logistics

Future cultivation pote-ntial
- High

Technology Readiness

T1: Biomass Processing
- Infrastructure available
- Established supply chain

T2: FT, AtJ, MtJ and pyrolysis
- Commercilly immature

Technological complexity
- Higher

Economic viability
- Moderate

Biofuel potential

In general	Moderate
In WS	Moderate

5. Conclusions

The feasibility assessment highlights both the potential and challenges of establishing a SAF supply chain in Western Colorado. While feedstock availability is diverse, no single resource can independently sustain a commercial-scale refinery, necessitating strategic feedstock aggregation and sourcing from neighboring states. However, this challenge should not be seen as a barrier but rather as an opportunity for regional collaboration and multi-state economic development.

Feedstock Viability and Market Dynamics

Camelina has emerged as a standout candidate, particularly in the Western Slope, given its low-input requirements, frost tolerance, and compatibility with existing farming infrastructure. Local farmers have expressed interest in cultivating camelina, recognizing its potential as a rotational crop and a viable alternative to winter wheat. While estimated annual production in the Western Slope stands at 4,774 metric tons, statewide production could reach 307,240 metric tons, covering 32.9% of a refinery's feedstock needs. Soybean and canola from Eastern Colorado offer an additional 174,096 metric tons and 148,770 metric tons, respectively, contributing 40.7% of necessary supply. Combined, oilseed feedstocks could cover 68% of refinery requirements, demonstrating the feasibility of a multi-feedstock SAF production strategy.

Despite these advantages, securing stable market commitments remains a challenge. Camelina is still considered a minor crop, and its widespread adoption depends on strong market assurances, financial incentives, and investment in regional processing facilities. Without local crushing and extraction infrastructure, producers may need to transport raw seed or oil, increasing costs and logistical complexity. Supporting farmer adoption through yield risk management programs and contractual stability will be essential in scaling camelina-based SAF production.

Biomass Utilization and Logistical Considerations

Forestry residues present a high-potential biomass feedstock, with an estimated annual availability of 889,500 metric tons—surpassing the volume required for a pioneer-scale SAF refinery using FT conversion. However, challenges remain in collection logistics, transportation, and stakeholder coordination. Western Colorado's forests are managed by multiple agencies, requiring careful engagement to ensure a consistent and sustainable supply of forestry residues while balancing environmental protections and wildfire mitigation efforts.

Similarly, municipal solid waste (MSW) presents a scalable feedstock but requires infrastructure enhancements to become a viable SAF resource. The region generates 534,300 metric tons of MSW annually, with 304,530 metric tons consisting of organic fraction suitable for SAF conversion. While individual landfills do not produce enough feedstock independently, aggregating OFMSW from multiple counties would provide a sufficient supply to support a pioneer-scale SAF facility. However, current landfill operations lack pre-sorting processes, making investment in waste separation technologies and centralized processing hubs a key priority for future development.

Economic and Workforce Impacts

Beyond feedstock viability, SAF deployment represents a significant economic opportunity. Developing a SAF refinery would support job creation in agriculture, forestry, waste management, transportation, and refining while addressing employment gaps left by the decline of coal, oil, and gas industries. The transition to SAF production would not only reduce aviation-related emissions—aligning with Pitkin County's sustainability goals—but also stimulate investment in rural economies, creating a new demand for skilled labor across multiple sectors.

Final Considerations

Western Colorado has the key ingredients for SAF success, provided that market structures, infrastructure investment, and policy support align to ensure long-term viability. While complementary feedstock sourcing is necessary, this should be viewed as a strength rather than a limitation, reinforcing interstate cooperation and diversified SAF production strategies. With targeted investments in farmer engagement, logistics, and processing infrastructure, Western Colorado could become a central contributor to a multi-feedstock SAF industry, driving economic growth while advancing aviation decarbonization.

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Annex I – Remote Stakeholder Interaction Record Keeping

STAKEHOLDER INTERACTION RECORD KEEPING IN PERSON MEETINGS, ONLINE MEETINGS AND CALLS				
Date	**Stakeholder**	**Feedstock**	**Comments**	**Follow up**
4/4/2025	Pitkin	KoM	Admin and workplan revision	
4/8/2025	Todd, Cody, Ben, Alec	KoM Mesa County	Revision of potential stakeholders to contact and feed-stock. New list of stakeholders identified by Mesa. Savia to present during Public hearing on May 6th	email from Damiana to Todd with an intro to the project and Savia for him to use with stake-holders. Email from Todd to connect to stake-holders
4/8/2025	Atlantic Aviation - Jonathan	Aviation fuel Provider	Understand aviation services Atlantic provides for GJT, ASE, EGE, and RIL	Jonathan to connect us to their CAF provider.
4/8/2025	GJEP	evaluation of current projects and incentives on economic develop-ment for the region	Key focus is on job creation. The area has a highly skilled workforce which is important when constructing and operating a SAF facility. They also have a site selec-tion tool and work closely with the Colorado Economic Development association.	In-person meeting scheduled for May 8th at GJEP offices.
4/8/2025	Greg	KoM Delta County	Agriculture, animal, MSW, forestry, waste water - all worth exploring. Will establish contacts with intro email and set up in person meetings including one with farm-ers.	Greg will make the intro emails, organize one-on-one meetings with relevant stakeholders and schedule a meeting with farmers on 1 or 2 May.
4/14/2025	Chris - Delta bricks	Industrial gas (me-thane)	Discussed the possibility of using methane captured from their abandoned coal mine as a feedstock. Chris-topher shared some preliminary figures regarding an-nual quantities, methane concentrations, and future production plans. He offered to give a tour of the facili-ties when we are onsite in the Western Slope.	Greg sent more information on volumes. Insuf-ficient for SAF facility
4/14/2025	Jeff	MSW	Details on the MSW project and on going negotiations. Will remain on the sidelines during the progress of the study.	will remain alert to our progress

4/18/2025	Ben	Brainstorming on his previous research on SAF and local production	Little volumes of many existing and potential feedstocks, GTL could become a tangible option, much use of imagination to understand how to value if possible, the combination of all that available.	None
4/18/2025	Janie Van Winkle - Charlie Talbott	animal waste / agricultural waste - orchard	Generally, a region of lean meat production, not much fats but yes animal waste for fermentation that today goes to landfill. Argo-west initiative – business incubator in Grand Junction. Food waste remediation could also offer an opportunity from schools, hospitals, etc. Orchard waste - 96% goes to fresh consumption, 90% of that not suitable for market goes to secondary market. Best bet would be to connect with wine producers and evaluate use of grape marc.	Janie to connect us with camelina seed producer and small rendering plants in the region. Charlie to connect us with wine producer.
4/22/2025	William Edwards - Andrew Martsolf	Forestry & other Natural Resources for fuel processing	Biomass is mitigated to minimize wildfire threats through mastication (chipping) which is very labor intensive. The USFS is very interesting in finding a use for the waste but volumes are limited. They suggested that we contact the White River Forest are who has more volume. Another potential feedstock is beetle kill timber but this may not be a long team solution.	Bill Edwards introduced us to Bill Williams from the White River Forest areas. We will schedule an online meeting and a site visit to get more information.
4/22/2025	GJT Dylan Heberlein	airport	GJT does not have a sustainability team nor specify goals beyond obligations (noise, soil, waste, waste water, etc.). No concerns on LAQ given the remote location. No plans specific to SAF. General aviation includes business travel as well as military and other at lesser extend. Commercial flights	Dylan was supposed to put us in contact with someone from West Star Aviation
4/23/2025	Amber Swasey	Natural Resources	Amber suggested the following feedstocks: latex paint, brewery waste (spent hops), used tires, medical waste, and agricultural waste and residues. She also suggested that we consider the Price Utah landfill for MSW. Finally, she suggested that we consider abandoned oil wells and methane from landfill.	We are following up with the appropriate stakeholders and have a meeting on May 7th with the Colorado Energy office to explore in more detail.

4/23/2025	Diane Jackson, Dan Bartholomew, Rich Englehart	airport	New FBO w/ Atlantic specifies the acquisition and provision of SAF, endeavor to purchase from closest location and to develop new fuel farm. LAQ – setting up a program to measure LAQ at the airport 7-9 stations to be set up in the next 3 months. ASE committed to aligning w/ resolution of county board to reduce by 20% emissions overall airport operations. Support for SAF use could follow noise initiative - flight with integrity program.	Diane to assist in getting in touch with CAF provide to Atlantic. The aim is to understand from where they are currently sourcing SAF and if it is neat or ASTM D1655.
4/25/2025	Troy Waters	Agriculture - camelina	Exploring with camelina as a drought resistant crop to prepare for cuts in H2O allowances. Currently producing camelina seed for Vision Bioenergy Oil Seeds. A substitute for winter wheat with 50% H2O and fertilizer need. 85% of harvested seed comes out clean using combine for alfalfa. A rotational crop with alfalfa and alternative to remaining fallow in the winter. Yields on the 235 acre between 1800-900 lb./acre, average of 1500 lb./acre. Crashing is in South Dakota and SAF refinery in Louisiana. At $0.75/lb., camelina becomes attractive crop vs winter wheat, today only paying max $0.35. Contact COA water to understand subsidy to remain fallow as H2O conversation measure vs. producing camelina.	Damiana to contact with Greg Peterson from COA water and Stuart Smith from Vision Bioenergy Oil Seeds, mention Mr. Waters.
5/6/2025	Grand Junction Public meeting	-	Presentation of the project.	None

5/7/2025	Randi M. Kim, P.E. (Utilities Director, City of Grand Junction) & Kurt Carson (Wastewater Services Manager)	Wastewater sludge and industrial gas (Methane)	• The waste plant serves about 80 000 people • They are currently changing their process from press to centrifuge • They produce biogas but it used for compressed natural gas (for vehicles). o Production of about 250-350 GGEs per day (variable) o Demand greatly exceeds supply o They have long-term agreements to respect • For these reasons, biogas is not a good candidate for SAF • They are interested in the potential of biosolids as it is a problem to dispose of. • Kurt will send us the production numbers • Aggregation is not an option o Concern about PFAS o Trucking from Delta is too far	Agreed that there was not potential to produce SAF since they produce RNG and do not have enough volume. I sent them the technical information about the Firefly project in case the situation changes in the future.
5/7/2025	Jennifer Richardson Mesa Landfill in person	MSW	They treat 140 000 tones per year and 60 000 tones goes to a private landfill on the Utah border. Waste is 1/3 trash, 1/3 recyclables and 1/3 organic waste. Trash is not sorted. Methane is not collected but there is an initiative to convert it to RNG as per new state laws. There is also a plan to construct a new MURF (Recycling Facility). There are no space constraints and the expected life of the landfill is 50 years. There not a lot of seasonal variation and growth is about 3% per year. There is no trash sorting.	Jennifer sent the Western Colorado Waste Audit
5/7/2025	Online meeting with Colorado Department of Energy Will Mannes (CEO) David Ulane (CDOT) Quinn Antus (CEO) Micheal Turner (CEO)	Colorado SAF Strategy (feedstocks, policy, incentives, energy)	Colorado is developing a SAF plan and is willing to work with us. They are interested in in-sate production but are open to feedstock souring form elsewhere, especially neighboring states. They know that there is not enough local feedstock. Their main goal is CI reduction. The state has several incentive programs to encourage SAF production. (see meeting notes for more details).	Keith contacted Kristen Managing Director with the Colorado Department of Agriculture o Ashley, Forest Carbon Specialist., and Amanda. Associate Director, both with the Colorado State Forest Service o Elise with the Office of Economic Development and International Trade (OEDIT).

SUSTAINABLE AVIATION

5/8/2025	In person meeting with Curtis Englehart (GJEP) in their office in Grand Junction	All	Curtis gave us documentation and explained the economic incentives available for companies to set up in Grand Junction	None
5/8/2025	Bill Jackson and Kevin Warner White River Forest (USDA)	Forestry residues	They explained how the forest is managed and believe that there is a lot of potential produce biofuels from dead trees which is a bid problem for them. Unfortunately they do not have a lot of hard data and their forestry management plan is a bit old. They are working to update it.	Suggested that we contact the CDA for more data
5/9/2025	Eli Jennings Clifton Sanitation (online)	Wastewater sludge and gas (methane)	Alec shared the details about how wastewater treatment is done at Persigo. They do not capture the off gas currently but could consider it in the future. They do not produce large quantities of sludge	Agreed that there was not potential to produce SAF do not have enough volume. I sent them the technical information about the Firefly project in case the situation changes in the future.
5/9/2025	Brian Pettet Pitkin County Landfill (online)	MSW	They treat 62 0000 MT of waste per year with a very high percentage of C&D waste (34 000 MT). No sorting at the landfill but a diversion program is in place. They compost 17 000 MT per year. They have just received $27 million to expand the landfill and will not run out of space for70 years. Growth rate is low 1-2% per year. They do not capture methane.	None

SUSTAINABLE AVIATION

5/12/2025	In person meeting with Colorado Office of Economic Development and International Trade in person in Denver Dana Bakshani, Jeff Kraft and Michelle Hadwiger (joined by TEAMS) Sam Anderson-Energy Specialist & Program Administrator	Incentives to build a SAF facility in Colorada	Incentives are technology and feedstock agnostic. They are based on the number of jobs that are created in Colorado. Incentives are based on a competitive bid. For example, a company would have to say that it is considering to put a SAF refinery in several states and Colorado would have to show why it is the best. This is to avoid giving money to a plant that would already be built here anyways. The Western Slope needs to show that it has unique advantages and qualities. In addition, a plant built to only serve West Slope airports would be ineligible for incentives. It needs to serve a wider area. As currently planned, a SAF refinery in the West Slope would be a no-go for incentives unless they can show why the Western Slope has unique advantages over other areas. For example, a company like Lanzajet or Montana Renewables would have to say that they were considering several states for another SAF refinery and the West Slope would have to show why it is better than the other states in terms of feedstock, manpower, technology, etc.	Keith to send project information and to ask Pitkin if we can share report when finished. They will send summary of incentives and evaluation grid.
5/14/2025	Tyler McDermott Western Colorado Alliance for Community Action	Agricultural crops + energy	Tyler told about the activities of the Alliance and how they support environmental initiatives such as solar. He was sportive of establish a SAF industry in Western Colorado	Keep him informed.
5/15/2025	Johan Malan-Topsoe	ATJ,MTJ, HEFA and FT technologies	On a confidential basis, Johan shared with us his knowledge regarding the TRL of various technologies, as well as some of the unpublished technological difficulties that some companies have experienced and his views on the state of the industry.	Johan to provide more information.
5/15/2025	Prentice Ashley, Mathew Shlitz, Stephen Rudolph, Timothy Reader Colorado State University	Agricultural feedstocks	Water rights are critical. It would be good to have another winter crop. It was suggested that we extend our scope to Utah.	None

5/22/2025	Kristin Boysen- Managing Director of CDA's Ag Drought and Climate Office & Sam Anderson-Energy Specialist & Program Administrator	FOGS, Ethanol and Forestry Waste	**FOGS** No potential for FOGS. The state produces 2M USG of FOGS but consume 70-80M USG They need all the oils possible for RD. In Colorado, all the oils are needed for RD. The demand is 1B USG/yr, but they only produce 200M meaning they must import oil - They looked at UCO but there is not enough, and the logistics are not good - The main oil product is sunflower oil (1M USG/yr) but it is a food crop and producers get $8-10/USG so they are not interested in other uses - They looked at other oils, such as camelina, flax and rapeseed but they do produce large quantities. They do not produce large quantities of soybean oil due to the climate. Camelina production is catching but slowly. - They produce 500 000 USG of corn oil which could be interesting, but in the eastern plains - The biggest source of FOGS is tallow and chicken fat coming from the eastern plains **Ethanol** - Eastern plains have the highest density corn density in the world - The corn is for animal feed, not for human consumption. That is why there is so much tallow and 3 ethanol plants on the eastern plains. - There is a lack of ethanol in the state so it would have to be imported for a SAF plant (this is wat I concluded in my study **Forestry Wastes** - They both agreed that forestry waste has lots of potential, especially in the west. Colorado has one of the biggest forests resources in the US (14th or 15th) - As others have told us, they have a HUGE problem with beetle kill trees. They have 170 000 dead pine trees stacked in piles and 10 million dead trees that need to be	Sam sent usus biodiesel reports for Eastern Colorado.

			cut down - Colorado used to be one of the largest lumber producers in the US but most of the mills have shut down and they are looking for economic opportunities in the industry	

CONTACT ATTEMPTED -NO RESPONSE		
Name	**Institution**	**Feedstock**
Austin Chalfant	Hotchkiss Redemption sawmill	Forestry residues
Chelsie Miera	West Coast Colorado Oil and Gas Association	Industrial gas/co-processing
Stuart Peterson	Vision Bioenergy Oil Seeds	Camelina
Greg Peterson	CO Ag Water Alliance	Water use and quality in farming
Derek Wagner	Colorado Mesa University	agriculture/animal/ forestry
Dr. Harry Cabot	CSU Fruita Research Station	agriculture/animal/ forestry
Douglas Dean	CSU Tri River Extension	Agricultural & Livestock Resources
Wil Mannes	Colorado Department of Energy	All feedstocks
Bill Jackson	White River Forest	Forest waste
TBD	Suncor	Industrial gas/co-processing
Front office	Hotchkiss Redemption sawmill	Forest waste
Brian Pettet	Pitkin Landfill	MSW/methane
Dylan Haberlein	Grand Junction Airport	feedstock blending
Chelsie Miera	West Coast Colorado Oil and Gas Association	Industrial gas/co-processing
Eli Jennings	Clifton Sanitation	Sewage
Matt Haifley	Fruita Waste Water	Sewage
Randi Kim	Persigo Wastewater treatment	Sewage
Dave Epp	Vegetation Management West	Agricultural Waste
Michelle Hadwiger	Colorado Department of Economic Development	All types of feedstocks

Western Slope
Sustainable Aviation Fuel Feasibility Project

SAF Producer Interviews and SWOT Analysis (V2.00)

Version number:	2.2
Dissemination level	CO (confidential)
RFP 020.25:	Revised Scope of Work – SAF Producer Interviews and SWOT Analysis
Date:	12.16.2025
Lead beneficiary:	Pitkin County
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Introduction

This document presents the outcomes of the Revised Scope of Work undertaken as part of the Western Slope Sustainable Aviation Fuel (SAF) Feasibility Project. Following the completion of Task 1, which assessed regional feedstock availability and identified significant structural and institutional barriers to near-term SAF development, the project partners elected not to proceed directly to a full techno-economic analysis. Instead, they initiated a targeted stakeholder engagement to test whether industry participants viewed any practical pathways as viable under current or foreseeable conditions.

The purpose of this Revised Scope of Work was to engage directly with SAF producers, technology licensors, and feedstock developers to validate Task 1 findings, understand minimum commercial requirements, and assess whether any feasible SAF pathway could reasonably emerge for the Western Slope. The analysis below summarizes insights from six stakeholder discussions and focuses on how industry perspectives align with, reinforce, or challenge the barriers identified in Task 1.

Comparative Briefing – Stakeholder Engagement

Table 1 below compares the three non-lipid SAF technology providers, Topsoe, Syntech, and LanzaTech, highlighting their roles, technology pathways, development maturity, feedstock compatibility, and potential fit with the Western Slope.

Table 1 - Technology Providers (MSW / Non-Lipid Pathways)

Category	Topsoe	Syntech	LanzaTech
Role & Business Model	Technology licensor; integrates with Sasol FT for syncrude + Topsoe upgrading. Does not build or operate plants. Technology provider to MR.	Developer of modular MSW-to-syngas-to-fuels units; proposes project at Eagle landfill; strong DoD pedigree.	Converts syngas to ethanol via bioconversion; ethanol upgraded to SAF via ATJ (LanzaJet). Uses partnership model.
Pathway & TRL	Gasification → FT → hydrotreating/hydrocracking. FT and upgrading fully commercial at large scale.	SERES sorting + BioMax syngas module + LiquidMax upgrading. No commercial SAF yet; ASTM qualification unclear.	Syngas fermentation to ethanol. ATJ is ASTM-certified but higher cost than HEFA and lower yields from certain feedstocks.
Scale & Economics	Optimal ~14–16 thousand barrels per day; small units possible but less competitive; suggests exporting prepared waste to large FT facilities.	Eagle concept: ~90–120 tons/day via modular units; incorporates biochar co-products that may support lower CI; cost competitiveness has not yet been demonstrated at commercial scale.	Standard ~30 million gallons per year facility; ~10 MGPY "small commercial" also feasible; WS MSW could support 10–30 MGPY if organic fractions were aggregated.
Feedstock Position	Requires high-quality, biogenic syngas; does not provide sorting or gasification.	Organic MSW (pelletized), agricultural residues, beetle-kill wood; internal sorting; technology is designed to minimize water requirements.	Highly interested in MSW; tolerant to syngas variability at a cost; open to forestry and agricultural residues.
Fit for Western Slope	Advises that local full MSW-to-SAF plant is not viable at current volumes; recommends preparing waste (pelletizing) and exporting.	Pioneer-scale at Eagle is possible but SAF certification, blending logistics, and economics are major risks.	Could site 10–30 MGPY if MSW aggregation is solved; otherwise, distributed gasifiers + central ATJ.

Key Risks / Gaps	Need consistent clean syngas; water use at gasification; competitiveness drops at small scale.	ASTM qualification status is still evolving; CI assignment under development; blending, permitting, and market pricing considerations pending.	High ethanol cost; MSW aggregation constraints; significant input needs (water, H_2, power).

Table 2 below compares World Energy, Montana Renewables, and Sustainable Oils, representing the mature HEFA sector and the primary agricultural feedstock pathway, with emphasis on their scalability, logistical needs, partnership potential, and relevance to the region.

Table 2 - HEFA Producers & Oilseed Feedstock Supplier

Category	World Energy (WE)	Montana Renewables (MR)	Sustainable Oils (SO)
Core Role	HEFA SAF producer; evaluating Colorado opportunities.	HEFA SAF producer; repurposed refinery with strong pretreatment and rail access.	Camelina developer and feedstock supplier (oil + meal). Does not refine or produce SAF.
Scale & Assets	Minimum ~50 MGPY; optimal 300 MGPY–1 BGPY; interested in Colorado but prefers large-scale settings.	Produces ~45 MGPY SAF; planning 150→300 MGPY; strong political and capital backing; efficient feedstock sourcing and SAF supply networks; prioritizes US and Canadian feedstocks.	~50,000 acres of camelina under cultivation; acreage expanding; bottleneck is crushing capacity.
Feedstock Strategy	Primarily tallow; vegetable oils with new pretreatment designs; strong focus on traceability.	Feed mix: tallow, UCO, vegetable oils. Very high feedstock flexibility via pretreatment.	Camelina; low-input, drought-tolerant crop; ~1,000–1,500 lb/ac yields; requires regional crushing.
CI & Sustainability	Tallow enables low CI; exploring shift to green H_2.	Achieves ~65% CI reduction; relies heavily on policy credits.	Camelina has low CI; protein meal valuable in livestock markets.
Western Slope Fit	WS not the most suitable location for a refinery, best if near DIA; WS → Front Range rail is key.	WS seed oil could be an input source if infrastructure is developed; sees crushing as major opportunity.	Western Slope as agronomically suitable for camelina expansion.

			Contingent to local crushing capability.
Key Constraints	Permitting and expansion near DIA limited; switching between feedstocks requires downtime without pretreatment.	Large-scale to make economics work; SAF volumes optimize when it sells at premium over renewable diesel; dependent on credits/policy incentives.	Crushing capacity gaps; rail access; expansion to grower program is currently limited to best candidates.

SWOT- Western Slope SAF Development Context

The following SWOT summarizes the combined insights from Task 1 and the six stakeholder discussions, distilling the region's key strengths, weaknesses, opportunities, and threats as they pertain to potential SAF development. The quadrant format provides a concise view of the factors that most directly influence pathway viability and regional competitiveness. For a full narrated version of the SWOT analysis, please see Annex 1:

SWOT - Western Slope SAF Development Context

Strengths

- Large volumes of forestry biomass available across multiple counties.
- Camelina is agronomically suited to Western Slope conditions.
- Strong stakeholder and county engagement in exploring SAF value chains.
- Existing rail corridors and logistics nodes that may support select pathways.
- Alignment with ASE's ZGF team, which is examining forestry value chains for sustainability research.

Weaknesses

- Long-term feedstock reliability depends on federal agreements and coordinated supply structures.
- No regional crushing, biomass conditioning, or pretreatment infrastructure.
- Feedstock sources (farms, forests, waste streams) are geographically dispersed.
- Oil-grain pathways require significant agricultural transformation and depend on local crushing capacity.
- Counties agreed that MSW aggregation across jurisdictions is politically, financially and logistically challenging
- Commercial readiness of Syntech's SAF process remains uncertain.
- Water and industrial land availability is limited in certain areas.

Opportunities

- Forestry biomass offers a promising pathway for further evaluation, supported by county-federal relationships and ZGF research interests.
- Oil-grain feedstocks could become viable if agricultural counties lead farmer development and support a crushing facility.
- The Syntech–Eagle initiative provides a learning opportunity for future localized MSW innovation.
- County-level incentives and concessions could improve investment attractiveness.
- Potential for deeper coordination among counties, agriculture, forestry, and airport stakeholders.

Threats

- Competing regions (e.g., MT, ND, KS, WA) have stronger agricultural and biofuel infrastructure.
- Forestry conversion technologies are advancing but still face market and commercialization risks.
- SAF project viability depends heavily on federal and state policy stability.
- Industrial siting may face community concerns in sensitive or high-value residential areas.
- Federal land dynamics, environmental reviews, or administrative changes could affect long-term biomass supply.

Conclusion

The Western Slope SAF assessment has progressed from a broad feedstock evaluation (Task 1) to a focused engagement with six relevant SAF stakeholders representing oilseed, forestry, and MSW pathways. This combined body of work provides a clear, fact-based picture of the region's opportunities, constraints, and strategic direction.

Task 1 demonstrated that the Western Slope has meaningful feedstock potential, but that each feedstock carries important considerations that must be addressed before a viable SAF pathway can be defined. Stakeholder calls validated several of these findings and surfaced the operational requirements, commercial expectations, and infrastructure needs that producers and technology developers view as critical to any future project.

The SWOT analysis reflects this reality. Forestry biomass, while abundant, depends on long-term federal land access, multi-agency coordination, and reliable logistics. Oilseed feedstock development offers promise but only if agricultural counties, particularly Delta, Montrose, and Mesa, lead farmer engagement and support the establishment of crushing capacity, as repeatedly emphasized by Sustainable Oils, Montana Renewables, and World Energy. Under current county decisions, MSW does not support regional-scale SAF production; however, the Eagle–Syntech project may provide useful insights for future localized waste-to-product initiatives.

Because the feasibility study concluded at the feedstock-assessment stage, many of the key analytical steps, logistics modeling, technology-pathway evaluation, economic screening, and supply-chain design, have not yet been performed. As a result, the opportunity for SAF production in the Western Slope remains present but undefined. The current body of work identifies promising elements yet leaves open questions that would need to be addressed to determine whether any SAF pathway is technically, logistically, or economically viable.

The extent to which the open questions from Task 1 can be resolved will depend on whether the conditions required for further pathway evaluation can be met. For oilseed feedstocks, this would rely on agricultural counties choosing to lead the upstream work, engaging farmers, developing capacity, and supporting the establishment of crushing infrastructure, elements that producers identified as prerequisites for any credible assessment. For forestry, long-term clarity would depend on sustained collaboration with federal agencies and regional forest management partners.

If these enabling conditions were to align, a more focused, pathway-specific assessment could provide the closure needed to determine the Western Slope's actual potential and guide any future decisions around partnerships, incentives, or infrastructure planning.

Annex I – Detailed SWOT Analysis

Western Slope Competitiveness for SAF Development

STRENGTHS

1. Abundant Forestry Biomass Across the Region

Task 1 identified forestry biomass as the most plentiful feedstock on the Western Slope, with significant volumes of forest residues and thinning materials produced annually. Local forest management companies expressed strong interest in utilizing this biomass, and counties report strong, long-standing relationships with federal agencies—critical for establishing and maintaining multi-decade supply agreements.

2. Favorable Regional Conditions for Camelina

Camelina is well-suited to Western Slope agricultural conditions. It performs reliably under dryland farming, fits into winter rotations, and requires relatively low inputs. Farmers showed openness to exploring camelina if supported by agronomic guidance, clear offtake structures, and midstream infrastructure.

3. High Stakeholder Engagement and Political Support

Task 1 and the stakeholder engagement process revealed strong interest across agricultural groups, forest managers, county governments, and economic development organizations. This collective willingness to explore SAF-related opportunities provides a strong foundation for regional collaboration.

4. Existing Rail Corridors and Logistics Nodes

Rail access through Grand Junction, Delta, Rifle, and nearby areas offers potential logistical support for biomass, oilseed, or liquid fuel transport. While the specific role of rail depends on the pathway pursued, the existing infrastructure is an enabler for certain supply-chain configurations.

5. Alignment With ASE Terminal Design Research Interests

Aspen/Pitkin County Airport's (ASE) terminal design team indicated that they will be engaging with the forestry value chain as part of their sustainability and research work related to the airport's future terminal and infrastructure. This creates natural alignment between regional forestry stakeholders and the airport's long-term planning efforts.

WEAKNESSES

1. Long-Term Feedstock Reliability Depends on Institutional Agreements

While forestry biomass is abundant, long-term feedstock reliability depends on secure access to federal lands, multi-decade agreements with the USFS and BLM, and coordinated work with forest management companies. These institutional elements must be evaluated to ensure they do not become barriers to sustained 20-year supply arrangements. Oilseed and MSW pathways also have reliability constraints of their own, including agricultural transformation requirements and county decisions on waste streams.

2. Lack of Midstream Infrastructure (Crushing, Pretreatment, Biomass Conditioning)

The Western Slope lacks oilseed crushing, biomass densification or pelletization facilities, and MSW pre-processing systems. These midstream gaps are foundational obstacles for oilseed and biomass pathways, increasing costs and reducing attractiveness for commercial developers.

3. Fragmented and Geographically Distributed Feedstock Sources

Feedstocks are scattered across the region: forestry residues span several counties and agencies, potential camelina acreage is dispersed across numerous farms, and MSW streams are independently managed by counties. This geographic distribution adds complexity and cost to feedstock aggregation and long-term contracting.

4. Oilseed Viability Depends on Crushing Infrastructure and County-Led Agricultural Development

Oilseed pathways require farmer training, new planting routines, and multi-year contracting. More importantly, without a crushing facility located in or near the Western Slope, all oilseed grain would need to be shipped out of state for processing and then shipped again to a SAF producer. This double transport increases cost, raises carbon intensity, and makes the region less attractive to HEFA producers. World Energy, Montana Renewables, and Sustainable Oils all emphasized that crushing capacity is essential for making oilseed feedstocks viable.

5. Difficulty to Aggregate MSW Across Jurisdictions

Project partners indicate that it would be politically, financially, and logistically challenging to transport the organic fraction of MSW across county lines. This removes MSW as a viable SAF feedstock at commercial scale, as no single county produces enough OFMSW to support conversion alone.

6. Uncertain Commercial Readiness of Syntech's SAF Process

Syntech has proposed a modular technology pathway with the potential to produce SAF. Stakeholder discussions indicated that several elements remain under development, including the current status of ASTM certification and the ability of smaller-scale deployments to achieve competitive market pricing. .

7. Water and Land-Use Constraints in Certain Areas

Certain parts of the Western Slope—particularly the Roaring Fork Valley—face limitations in water availability, industrial land, and community acceptance for siting industrial-scale facilities. These constraints may limit the flexibility of project development in specific counties.

OPPORTUNITIES

1. Forestry Biomass as a Promising Pathway for Further Evaluation

Forestry biomass is abundant, companies are willing to utilize residues, and counties have strong relationships with federal agencies. Additionally, the Aspen/Pitkin County Airport terminal design team has indicated they will be engaging with forestry value chains as part of their sustainability and research mandate while designing the new terminal. These factors make forestry a promising pathway for further technical and economic evaluation.

2. Oilseed Pathway Conditional on Agricultural Leadership in Key Counties

If agricultural counties such as Delta, Montrose, and Mesa decide to lead efforts in farmer engagement, capacity-building, and supporting a crushing facility, oilseed feedstocks could become viable. Stakeholders including World Energy, Montana Renewables, and Sustainable Oils noted that such infrastructure would make the region significantly more attractive for offtake partnerships and supply agreements.

3. Learning Opportunity from the Syntech–Eagle Initiative

While MSW is not viable for regional SAF supply, the Eagle–Syntech project provides an opportunity for counties to observe a local waste-to-products initiative. As the project advances, it may demonstrate performance, costs, and outputs that inform future decisions about localized MSW strategies without requiring regional aggregation.

4. County-Level Concessions Can Improve Investment Attractiveness

Counties may enhance their competitiveness through incentives such as streamlined permitting, long-term industrial land leases, tax abatements, support for infrastructure connections, or other development tools. Producers noted that such measures could influence siting decisions and reduce project risk.

5. Opportunity for Regional Coordination and Planning

The strong engagement shown during Task 1 and stakeholder outreach provides a basis for deeper regional coordination. Aligning counties, agricultural groups, forest managers, and airport stakeholders behind one or two prioritized pathways may increase certainty for potential investors and streamline planning.

THREATS

1. Competition From Regions With More Established Biofuel Infrastructure

States such as Montana, North Dakota, Kansas, and Washington have more mature agricultural supply chains, larger biomass pools, and more aggressive incentives for biofuel development. This competitive landscape places pressure on the Western Slope to differentiate itself through strategic partnerships or incentives.

2. Technology Maturity and Market Risk for Forestry Conversion Pathways

Forestry-to-fuels technologies continue to advance. Topsoe indicated that Fischer–Tropsch systems using forestry biomass are approaching commercial maturity (TRL 8). However, achieving fully commercial SAF production still carries market and technology risk. Even if full SAF production is not immediately viable, these technologies may be suitable for producing renewable energy streams for local applications such as ASE's ZGF work. Long-term performance, capital requirements, and market conditions remain important variables.

3. Policy and Market Uncertainty

SAF economics are highly sensitive to federal incentives, carbon credit programs, and transportation fuel policies. Fluctuations in these areas could affect project viability or investor interest.

4. Community Acceptance and Land-Use Challenges

Industrial projects near residential or environmentally sensitive areas may face community opposition. Concerns may include noise, traffic, air quality, and visual impacts, particularly in tourism-oriented communities.

5. Long-Term Supply Chain Risk for Federal Lands Biomass

While counties have strong relationships with federal agencies, supply continuity on federal lands can be influenced by administrative changes, environmental reviews, wildfire events, and shifting national priorities. Secure long-term agreements are critical for investor confidence.