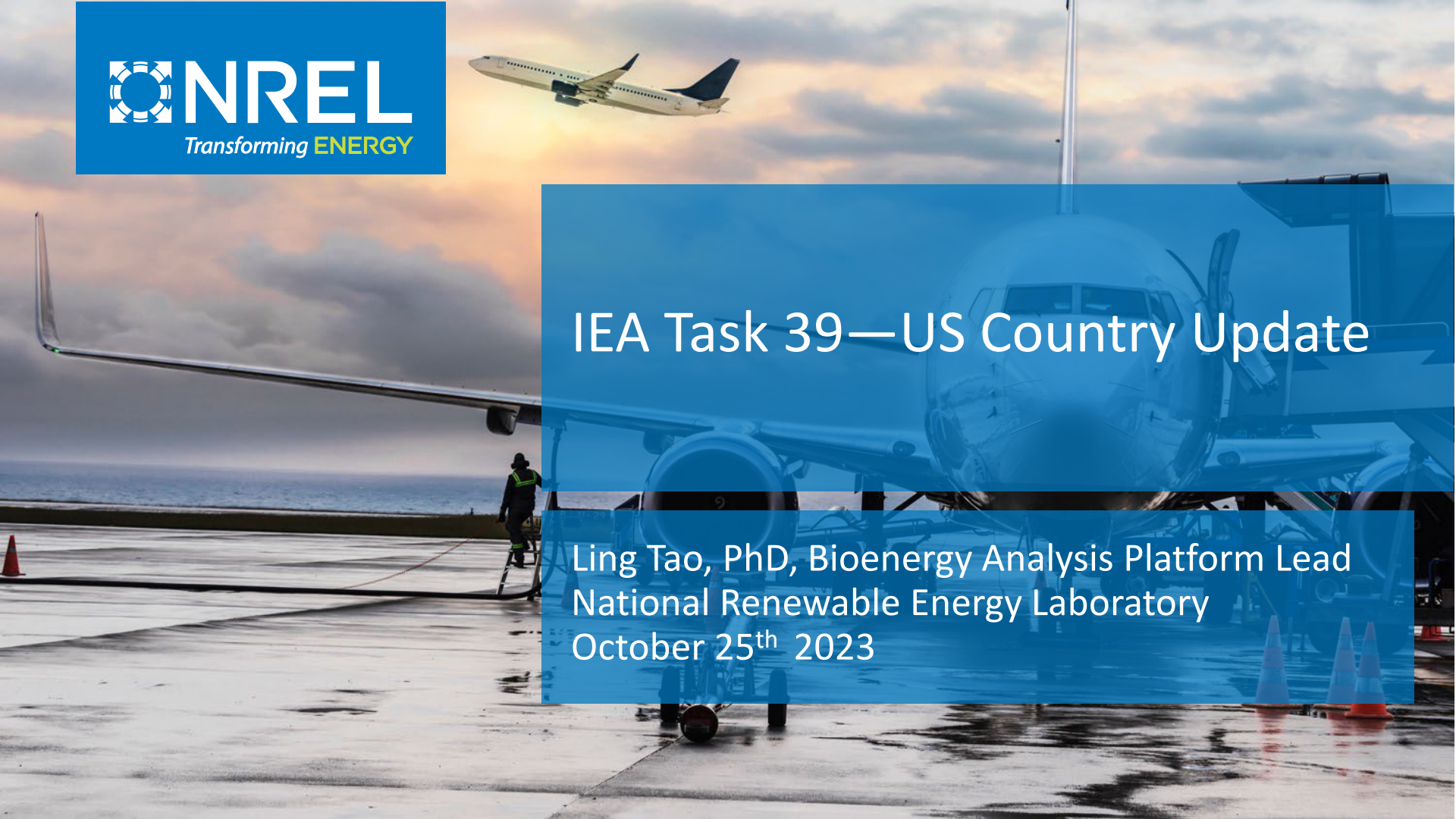
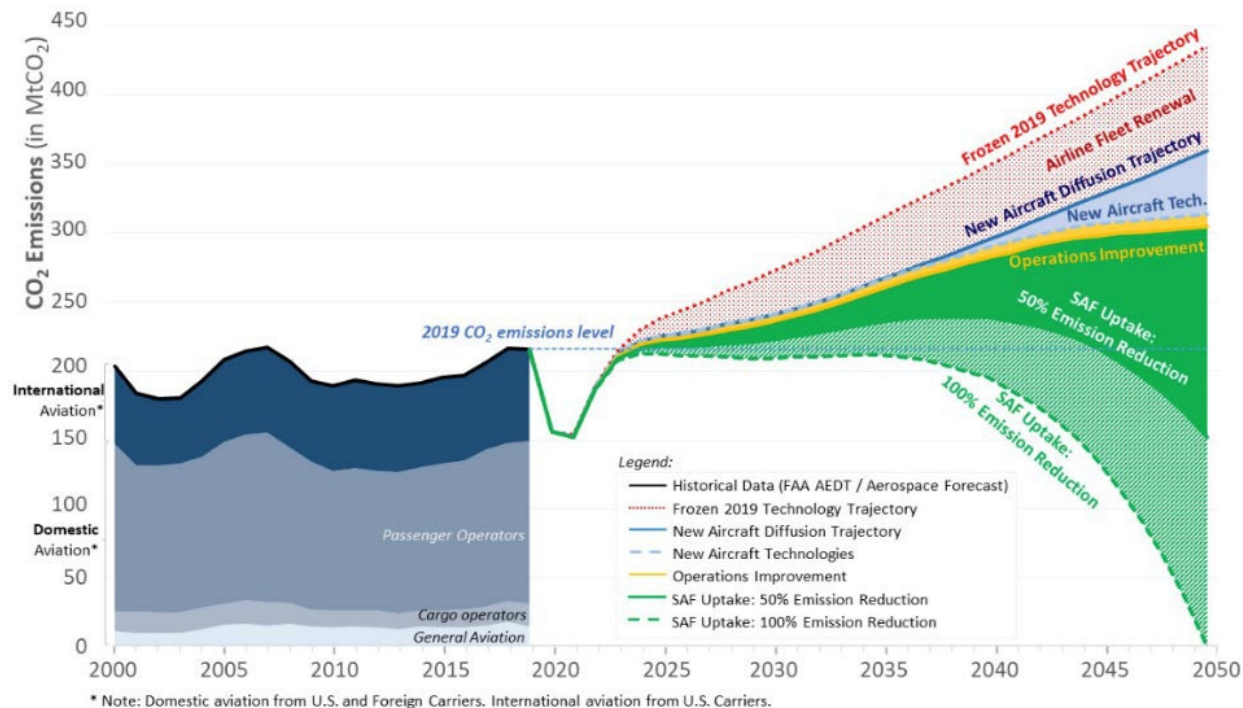




IEA Task 39—US Country Update

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SAF Grand Challenge



Target: 3B gallons per year of domestically-produced SAF, 100% SAF use by 2050 (SAF fuels with a minimum 50% reduction in lifecycle GHG emissions)

U.S. National Blueprint for Transportation Decarbonization

Summary of vehicle
improvement strategies and
technology solutions for
different travel modes that are
needed to reach a net-zero
economy in 2050

Source: The U.S. National Blueprint for Transportation Decarbonization

	1 icon represents limited long-term opportunity 2 icons represents large long-term opportunity 3 icons represents greatest long-term opportunity	 BATTERY/ELECTRIC	 HYDROGEN	 SUSTAINABLE LIQUID FUELS
Light Duty Vehicles (49%)*		  	—	TBD
Medium, Short-Haul Heavy Trucks & Buses (~14%)		 		
Long-Haul Heavy Trucks (~7%)			  	 
Off-road (10%)		 		
Rail (2%)		 	 	 
Maritime (3%)			  [†]	  
Aviation (11%)				  
Pipelines (4%)		 	TBD	TBD
Additional Opportunities		- Stationary battery use - Grid support (managed EV charging)	- Heavy industries - Grid support - Feedstock for chemicals and fuels	- Decarbonize plastics/chemicals - Bio-products
RD&D Priorities		- National battery strategy - Charging infrastructure - Grid integration - Battery recycling	- Electrolyzer costs - Fuel cell durability and cost - Clean hydrogen infrastructure	- Multiple cost-effective drop-in sustainable fuels - Reduce ethanol carbon intensity - Bioenergy scale-up

- * All emissions shares are for 2019

† Includes hydrogen for ammonia and methanol
- The amount of available biomass, its geographic distribution, and technologies to sustainably convert that waste carbon into fuel are limited
 - The scale-up of sustainable fuel production requires developing and deploying advanced technologies to reduce cost and improve performance, while ensuring that life-cycle emissions and overall environmental and societal impacts are minimal.

RFS Biofuel Volumetric Requirements for 2023-2025

	Cellulosic biofuel (D3)	Biomass-based diesel (D4)	Advanced biofuel (D5)	Renewable fuel (D6)	Supplemental standard
Volumetric Targets (as billion RINs)					
2023	0.84	2.82	5.94	20.94	0.25
2024	1.09	3.04	6.54	21.54	-
2025	1.38	3.35	7.33	22.33	-
Percentage Standards (%)					
2023	0.48	2.58	3.39	11.96	0.14
2024	0.63	2.82	3.79	12.50	-
2025	0.81	3.15	4.31	13.13	-

- Ethanol mandate would be limited to 15 billion gallons.
- Biodiesel producers sought higher targets.
- All fuels included in the RFS are required to meet a minimum 20% reduction in lifecycle GHG emissions compared to petroleum-based fuels. Advanced biofuels include biojet fuels (SAF), requires to meet a minimum 50% reduction in GHG emissions

Conventional renewable fuel (D6)

Example feedstock: Corn starch
Required lifecycle GHG reduction: 20% or more

Advanced biofuel (D5)

Example feedstocks: Sugarcane, biobutanol, bionaphta
Required lifecycle GHG reduction: 50% or more

Cellulosic biofuel (D3)

Example feedstocks: Corn stover, wood chips, miscanthus, biogas
Required lifecycle GHG reduction: 60% or more

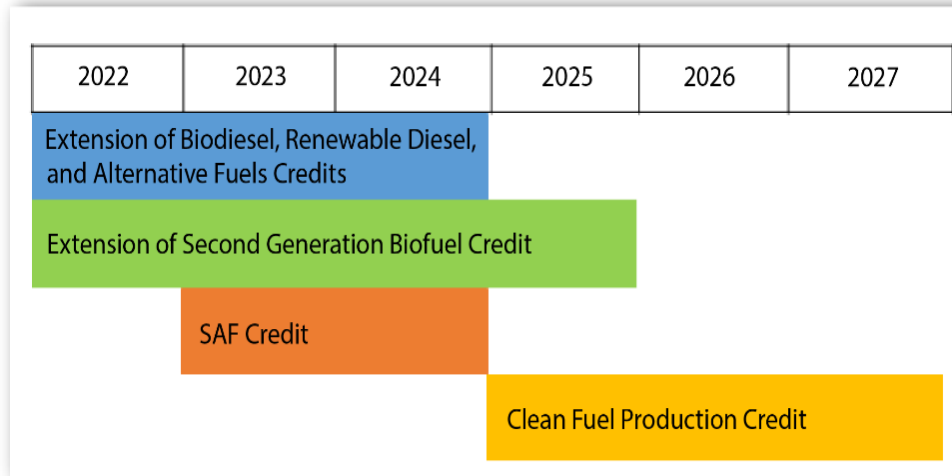
Biomass-based diesel (D4)

Example feedstocks: Soybean oil, canola oil, waste oil, animal fats
Required lifecycle GHG reduction: 50% or more

Source: <https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-annual-standards> and <https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuels-standards-rule-2023-2024-and-2025>

2022 Inflation Reduction Act: provides and extends multiple tax credits

- Previous biofuel credits extended
- Introduction of SAF Credit
- CFPC in 2025: largely replaces existing credits



2022 IRA (2023-2025)

Extension of Incentives for Biodiesel, Renewable Diesel, and Alternative Fuels, to Dec. 31, 2024	Biodiesel and Renewable Diesel Credit	\$1.00 per gal. , not in a mixture
	Biodiesel Mixture Credit	\$1.00 per gal of pure biodiesel, agri-biodiesel, renewable diesel blended with petroleum diesel resulting in minimum 0.1% diesel fuel mixture
	Alternative Fuel Credit	\$0.50 credit per gal, for sale or use for motor vehicle Natural gas, liquified H2, propane, P-Series fuel, liquid fuel from coal (Fischer-Tropsch), compressed or liquified gas derived from biomass
	Alternative Fuel Mixture Credit	\$0.50 per gal of alternative fuel used in mixtures of at least 0.1% gasoline, diesel, or kerosene (not allowed if ethanol/biodiesel tax credit applied)
Extension of Second-Generation Biofuel Incentives, to Dec. 31, 2025		\$1.01 per gal credit for production of qualified feedstocks: includes lignocellulose, hemicellulose, cyanobacterial and algal biomass

2022 IRA (2023-2027)

SAF Credit (Jan. 1, 2023 – Dec 31, 2024)	\$1.25 per gal for sale or use of qualifying SAF mixture, minimum of 50% lifecycle GHG emission reduction Supplemental credit of \$0.01 per gal for each additional percentage in lifecycle GHG emission reduction (up to \$0.50)
Clean Fuel Production Credit (Jan 1, 2025 – Dec. 31, 2027)	Production credit determined by a base or alternative credit per gal of qualifying biofuels, multiplied by an emissions factor based on lifecycle GHG emissions Base credit \$0.20 Alternative credit: \$1.00 (for qualifying facilities) SAF production base credit: \$0.35 (for qualifying facilities) SAF alternative credit: \$1.75 (for qualifying facilities)

Key Takeaways:

- Performance-based credits
- Increased support for SAF compared to other biofuels

State Policies

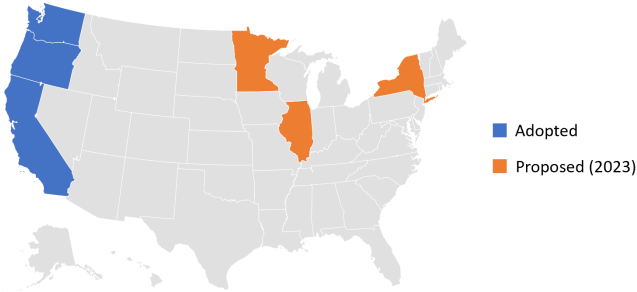
Adopted

CA	Low-Carbon Fuel Standard (LCFS) (2009, 2018): 20% reduction in CI by 2030 - SAF eligible for credits (production, importation)
OR	Clean Fuels Program (2016, 2021): 20% reduction in CI of transportation fuels from 2015 levels by 2030, 37% by 2035 - SAF eligible for credits
WA	Clean Fuel Standard (2019): 20% reduction in CI of transportation fuels from 2017 levels by 2034 SAF credit (2023): \$1.00 per gallon of SAF, min 50% reduction in GHG emission \$0.02 per additional 1% reduction in GHG emission - Locally produced SAF
IL	SAF Credit (2023): \$1.50 per gallon SAF purchased for use in state

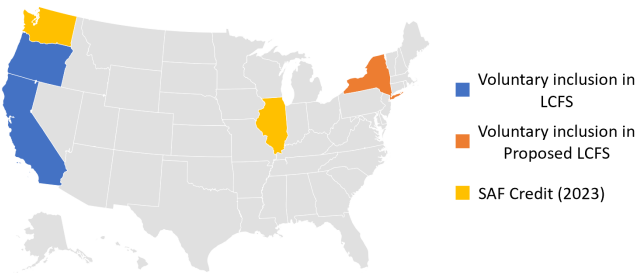
Proposed

IL	Clean Transport Standard (2023): 20% reduction of CI from on-road transportation by 2038
MN	Clean Transportation Fuel Standard (2023): Reduction in CI of transportation fuel supplied to state: 25% below 2018 level by end of 2030, 75% by end of 2040, 100% by end of 2050
NY	Clean Fuel Standards (2023): - Reduction of CI of road transportation fuels by 2030 - SAF eligible for credits

State LCFS or CFS



SAF: Voluntary Inclusion in LCFS or SAF-Specific Credit

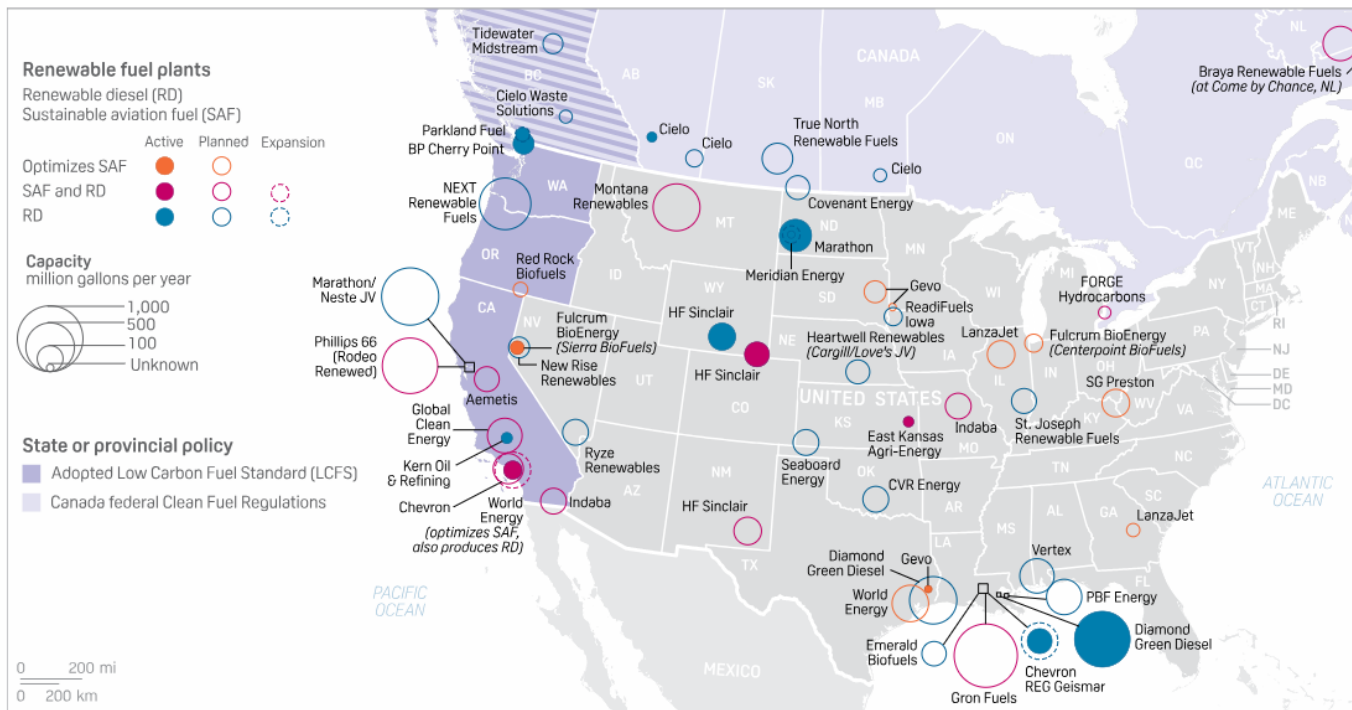


Key Takeaways for US Clean Fuel Policies

- EPA RFS for 2023-2025 demonstrates commitments to renewable fuels. Proposed changes also aim to include the use of credits for renewable electricity from biomass.
- The 2022 IRA extends existing credits supportive of biodiesel, renewable diesel, and alternative fuels through 2024, and second generation biofuels through 2025.
- The IRA also established two new credits: 1) the Sustainable Aviation Fuel (SAF) Credit for the sale or use of qualifying SAF meeting a minimum of 50% lifecycle greenhouse gas (GHG) emission reduction, and 2) the Clean Fuel Production credits (CFPC or so called PTC) for biofuels or SAF, and which include lifecycle GHG emission reduction considerations in biofuel credits and minimum requirements for SAF.
- A number of states have adopted policies establishing SAF as eligible for credits, or SAF-specific credits inclusive of producers and/or purchasers. These states have also based these incentives on lifecycle GHG emission reduction requirements.

Location and capacity of HEFA facilities in US

US REFINERS JUMP ON THE RENEWABLE FUEL BANDWAGON



Source: S&P Global Commodity Insights, EIA

Source: <https://www.spglobal.com/commodityinsights/en/market-insights/blogs/agriculture/090822-ira-inflation-reduction-act-us-biofuels>