DEPARTMENT OF ECOLOGY
State of Washington

Clean Fuels Program Rule Chapter 173-424 WAC

March 15, 2022

Welcome to the

Clean Fuels Program Rule

Chapter 173-424 WAC

Rulemaking Stakeholder Meeting

We will start at 9 a.m. PDT.

We will check sound 10 and 5 minutes before start.

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Sound Check

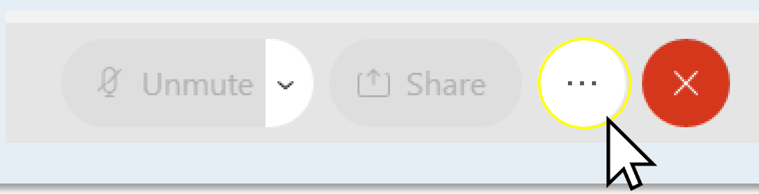
No sound? Connect your audio and listen for a sound check before we start.

All attendees are muted.

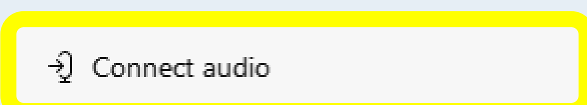
To change your audio connection:

1 → 2 → 3

1 Click on the 'More Options' button at the bottom of your screen.

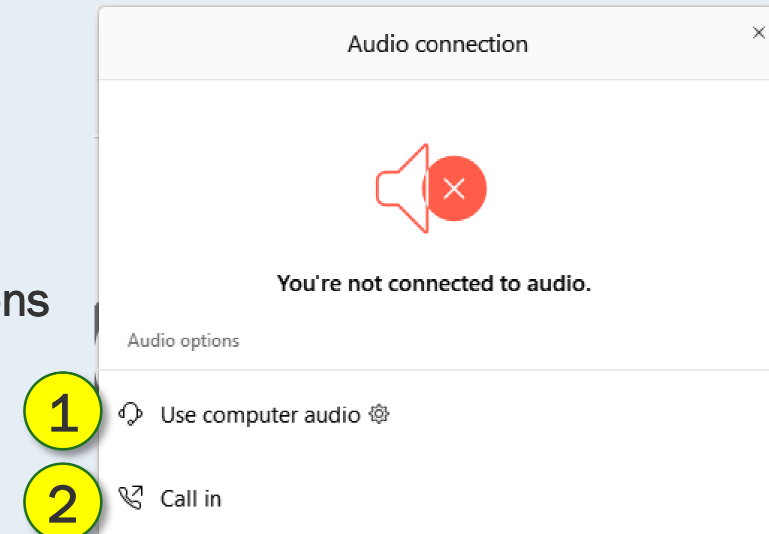


2 Select "Connect Audio" button.



3 Select Audio Connection

2 Options

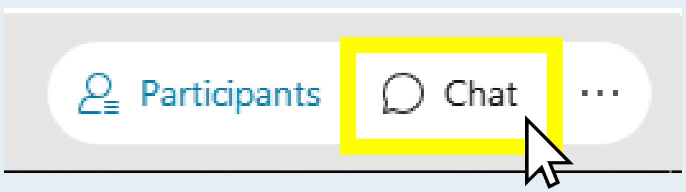


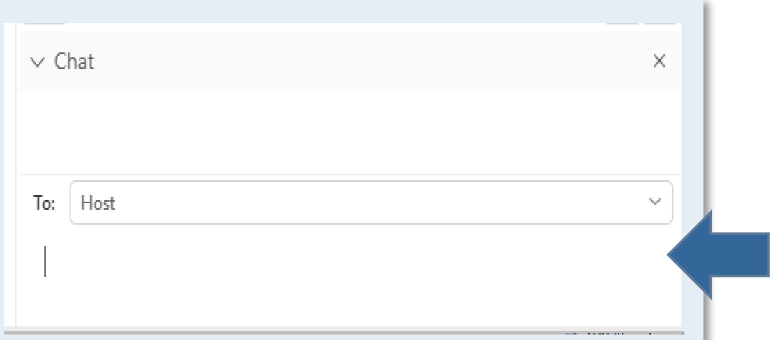
If you select "Call in," the system will provide you with a phone number and entry information.

How To Use the “Chat” Function

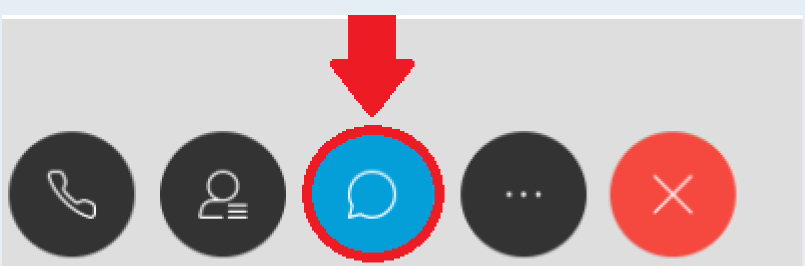
Chat with the host for technical problems

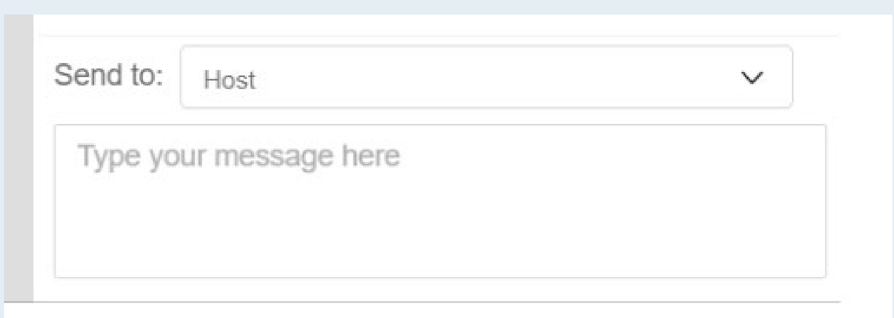
If you are using the WebEx application:





If you are using the WebEx browser:





How To Use the “Raise Hand” Function

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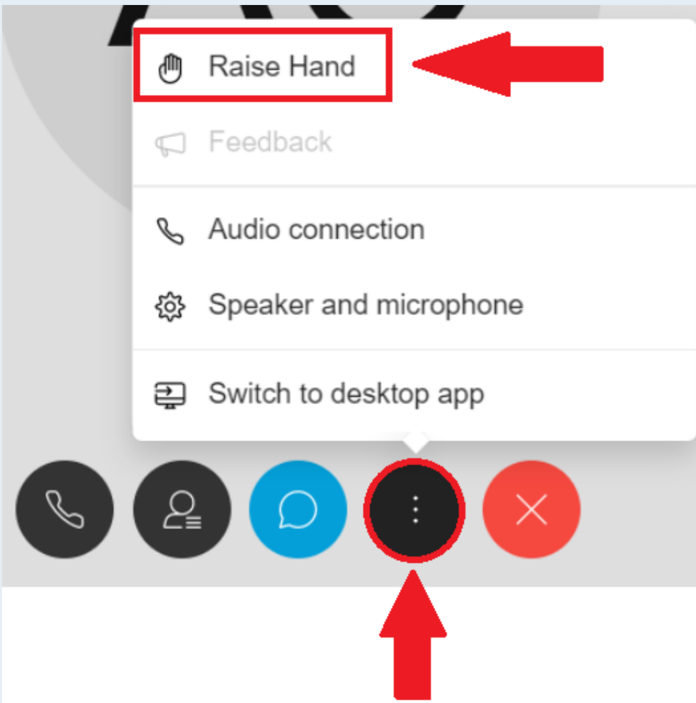
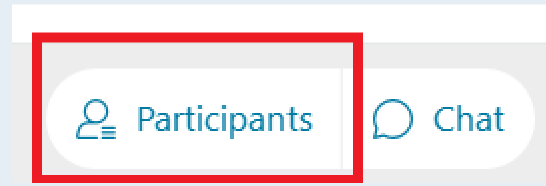
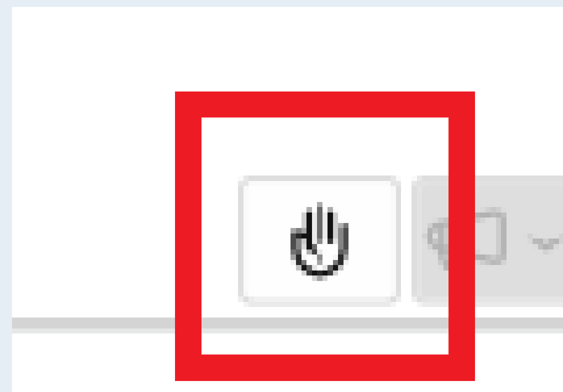
Joined by Browser



Joined by Application





Joined by Phone

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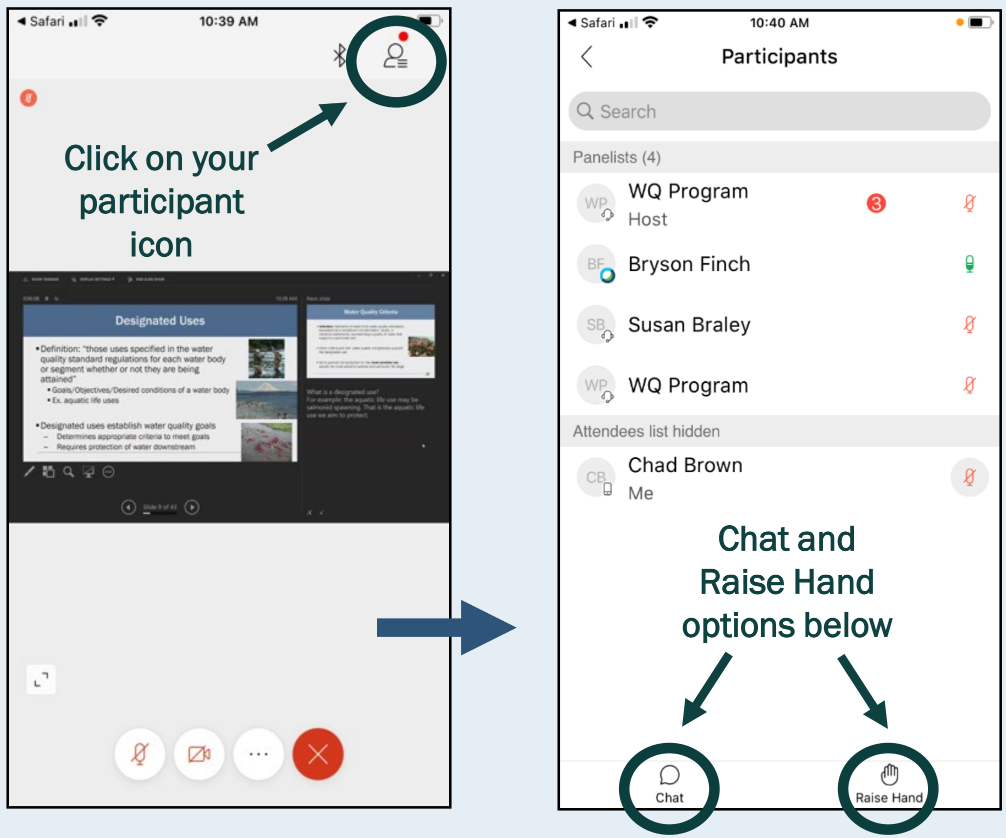
For Those Joining via Phone or Tablet



How To Participate

During today's question-and-answer period:

- **<u>Participants using computer or mobile app</u>: Use the "Raise Your Hand" button. This button is located in the lower right hand corner of the participant list window.**
- **<u>Participants listening in on the phone</u>: Press *3 on your phone. The system will show you have your hand raised. The host will unmute you at your turn and the system will announce that you are unmuted.**

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Start Recording

We will begin recording at this time.

Ecology Staff

- Eman Jabali – Host
- Tina Maurer – Co-Host
- Jason Alberich – Rules and Planning Unit Supervisor
- Rachel Assink – Rulemaking Lead
- Abbey Brown – Technical Lead
- Joel Creswell – Climate Policy Section Manager
- Debebe Dererie – Fuel Pathway Specialist
- Janée Zakoren – Outreach & Engagement Specialist

Life Cycle Associates and Trinity Consultants Staff

- Stefan Unnasch – Managing Director, LCA
- Love Goyal – Sustainability Project Manager, LCA
- Lucy Buchan – Managing Sustainability Scientist, LCA
- Alex Marcucci – Managing Consultant, Trinity

Agenda

1. Rule timeline
2. Stakeholder comments received and Q&A
3. Carbon intensity calculation model
4. Stakeholder comments and draft rule overview

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Rulemaking Timeline

Announce Rulemaking CR-101

Develop Rule

Stakeholder meetings

Oct 6, 2021
Nov 16, 2021
Jan 27, 2022
Mar 15, 2022
Apr 13, 2022

Propose Rule CR-102

Evaluate Comments and Respond

Adopt Rule CR-103

July 20, 2021	August 2021 – May 2022		July – August 2022	Sept. – Nov. 2022

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Stakeholder Comments

Abbey Brown

Comments Received

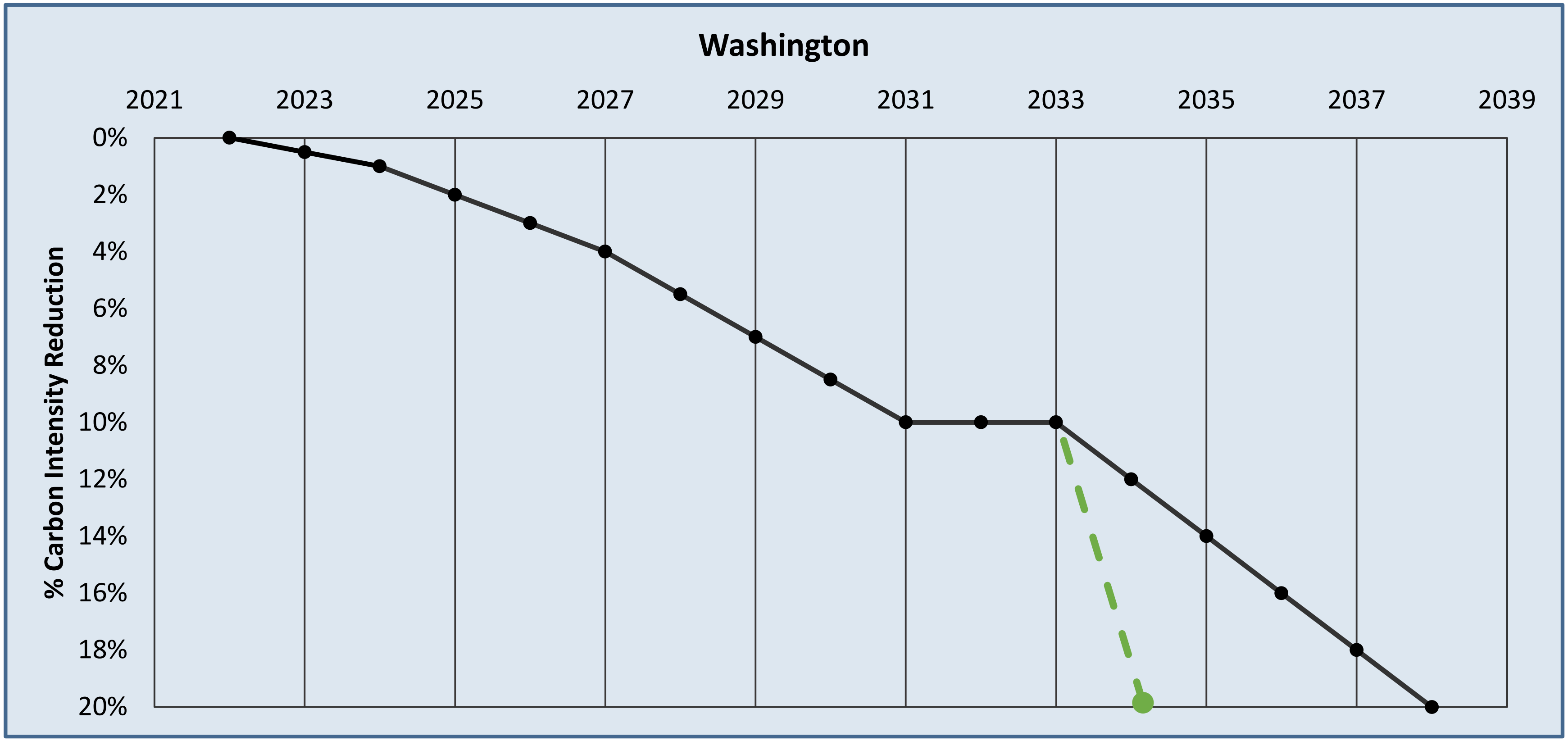
21 Acres	3Degrees	Airlines4America	Amanda Doxtater (no affiliation listed)
Carbon Removal Buyers & Developers Coalition	Charm Industrial	Clean Fuels Alliance America	e-Mission Controls
EVSE coalition	Jared Howe (no affiliation listed)	King County Executive	Pacific Merchant Shipping Association
Pierce County Councilmember Mello	RPMG	Smart Charging Technologies	WSPA

(Comments submitted between 1/18/2022 – 3/8/2022)

Comments on Carbon Intensity

Reduce the carbon intensity by 20% below 2017 levels by 2034.

(Jared Howe, Amanda Doxtater, Pierce County Councilmember Mello, King County Executive)



Comments on Carbon Intensity Standard

Do not use a separate CI benchmark for SAF – measure against the CI benchmark for diesel

Airlines4America

King County Executive

2023 should be a full compliance year

Comments on Fuel Pathways

Exempt all aircraft fuels (including conventional jet fuel, aviation gasoline, and SAF) and allow these fuels to generate credits. (Airlines4America)

Do not exempt dyed fuel for agricultural purposes, if possible. (21 Acres)

Allow for non-deficit-generating marine and rail fuels to opt-in to the program. (Clean Fuels Alliance America)

Include pathways for carbon removal technologies. (Carbon Removal Buyers and Developers group)

Allow carbon capture and sequestration (CCS) to generate credits. (Charm Industrial)

Include low-CI electricity and time of use charging pathways. (EVSE coalition)

Allow for capacity credits for DCFC. (EVSE coalition)

Comments on Reporting

- Allow reporting “at the rack” rather than “below the rack,” similar to California.
- Make the deadline for the third quarter reports be set on the second Friday of January of the following year.
- Do not include quarterly and annual crude oil volume reports (MCON) and incremental deficits in this rulemaking.

(WSPA)

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Comments on Public Fleets

- Public fleet owners should receive the right to credits generated from publicly-owned EV fleets.
- Allow fleet electricity charging credits to be able to be transferred.
- Give fleet owners the first right to credit generation.
- Allow for book-and-claim accounting for fleet electrification with renewable energy agreements generated off-site.
- Allow for advance crediting for public fleets.

(King County Executive)

Image source: https://www.intelligenttransport.com/transport-news/102336/low-carbon-vehicle-partnership-to-shift-focus-from-low-to-zero-carbon/

Comments on Fixed Guideway Systems

- Transit operators should get credits for these systems, regardless of method of charging. (King County Executive)

Additional Comments

- Allow electric airport ground support equipment, “eGSE,” to generate credits. (Smart Charging Technologies)
- Cap CCS credits instead of limiting eligible technologies. (Charm Industrial)

Image source: https://wsdot.wa.gov/sites/default/files/2021-11/2018-Rail-Fixed-Guideway-PTSS-Report.pdf

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Comments on EV Charging

3Degrees

- Use Oregon's definition of multifamily housing.

EVSE coalition

- Non-residential charging credits should be awarded to the owner/operator of the charging equipment.

EVSE coalition

- Credits generated by non-residential charging should not have revenue spending requirements, and non-residential charging by non-utilities should not be capped.

Comments on Forklifts

e-Mission Controls

- Only use a model year cut-off if there is demonstrable variation in efficiency

3Degrees

- EV forklifts: Charging equipment owner should generate credits

Comments on Definitions and Rule Text

Use the OR DEQ definition of SAF – specifically, include their language on co-processing (Airlines4America)

Ecology should hold a workshop to discuss approaches to claiming a lower CI for electricity used as a transportation fuel than the utility-specific CI. (3Degrees)

Clarify how Ecology is making decisions between which program elements included or not from other jurisdictions (WSPA)

Requests for clarification in the following draft rule sections:

- Registration, Reporting, Recordkeeping (3Degrees)
- Applicability, Exemptions, Designation of Fuel Reporting Entities for Liquid Fuels, Registration, Recordkeeping, Quarterly Reports, Specific Reporting Requirements, Annual Compliance Reports, Emergency Deferral, Forecast Deferral (WSPA)

Question and Answer

Keep questions related to stakeholder comments.



Carbon Intensity Calculation for Washington CFS

Draft Models and tools

Stefan Unnasch
Love Goyal

March 10, 2022

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Outline

- Carbon Intensity Calculation Overview
  - GREET Model
- Crude and Petroleum Fuels
- Electricity Generation
- Simplified Calculators
- Indirect Land Use Change Assessment ppt

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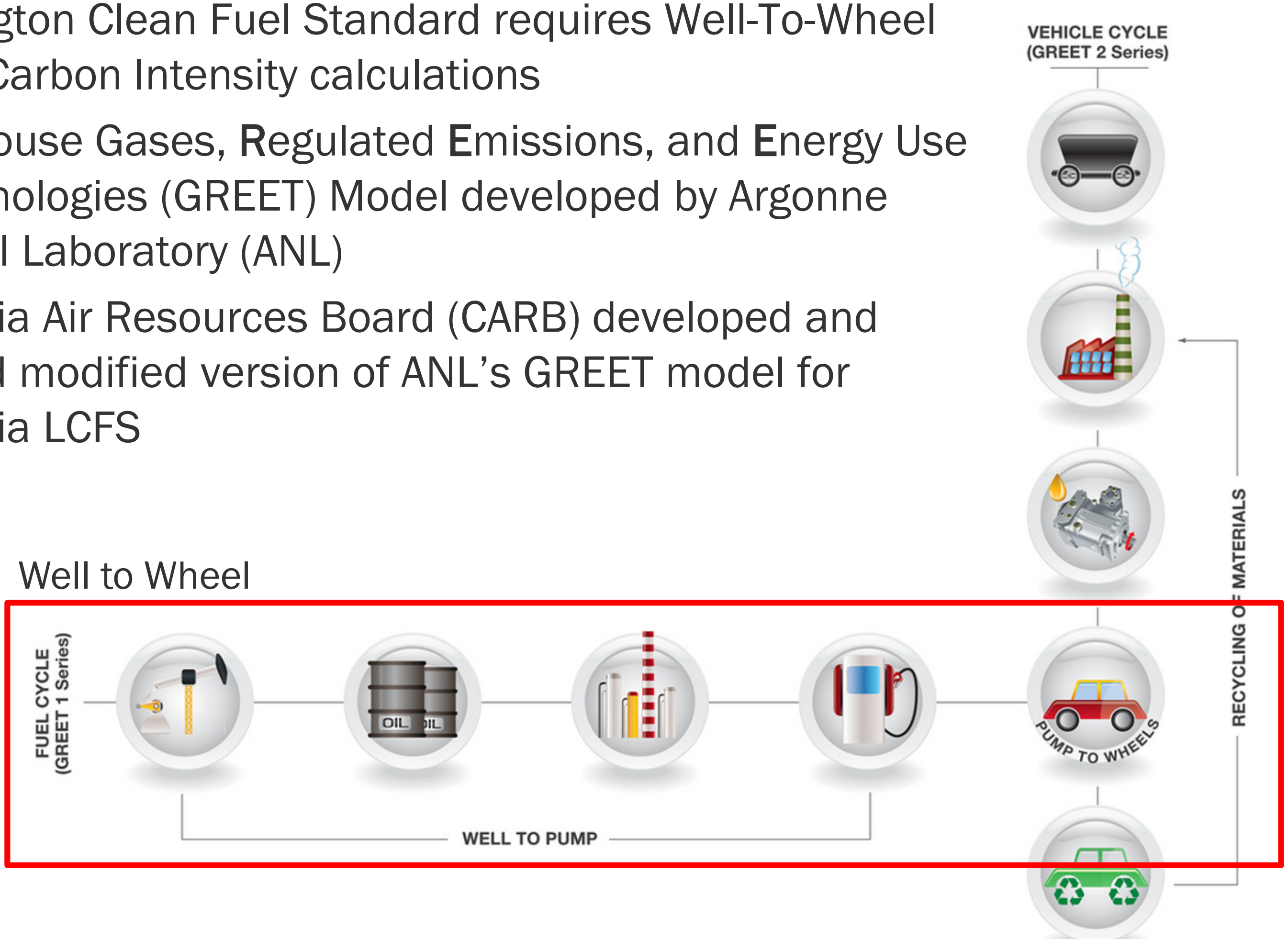
Carbon Intensity Calculations

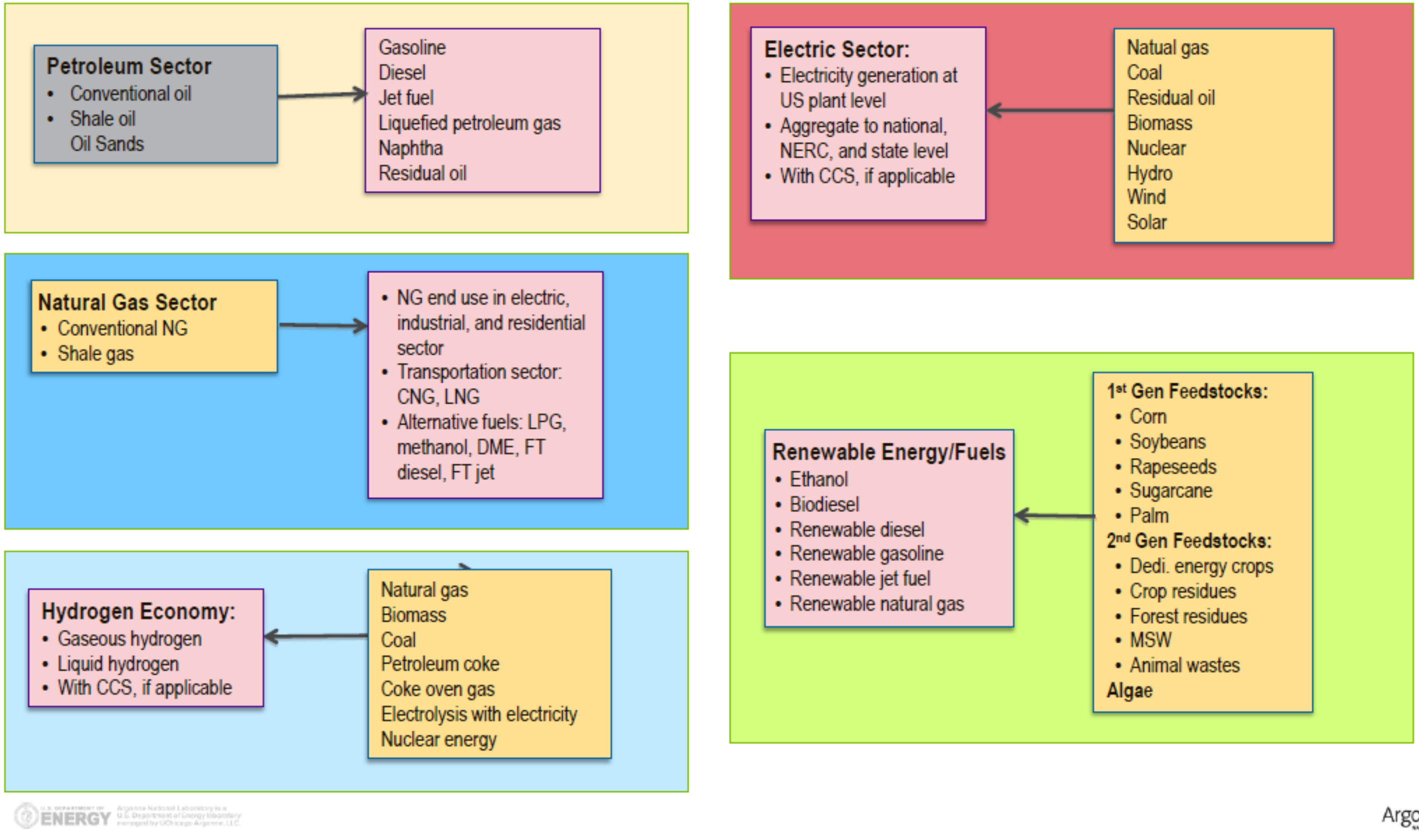
- Washington Clean Fuel Standard requires Well-To-Wheel (WTW) Carbon Intensity calculations
- **G**reenhouse Gases, **R**egulated **E**missions, and **E**nergy Use in **T**echnologies (GREET) Model developed by Argonne National Laboratory (ANL)
- California Air Resources Board (CARB) developed and adopted modified version of ANL's GREET model for California LCFS



Argonne National Laboratory

GREET Model and Calculators

- GREET includes regional detail
  - Crude oil, electric power
  - Life cycle results based on simulation year



WA-GREET Model Source

- Based on CA-GREET3.0 developed by California Air Resources Board (CARB)
  - Current version released by CARB on Aug 13, 2018
  - Underlying GREET1_2016 model developed by Argonne National Laboratory (ANL)
- Consistent with Oregon Department of Environmental Quality (OR-DEQ) approach to develop OR-GREET
- Majority inputs for fuel pathway CI calculations from CA-GREET3.0 retained in draft WA-GREET
  - Upstream life cycle results depend on model simulation year

WA-GREET: Key Changes

- Petroleum Crude and Products
  - Baseline WA average crude CI
  - Baseline petroleum fuel CI
- Electricity Generation
  - Added Washington average electricity mix
- Develop Tier 1 Simplified Calculators
  - Simplified CI calculators external to WA-GREET
  - Emission factors derived from WA-GREET
- Indirect Land Use Change Assessment

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WA Fuel Pathways

- Look up table CI values based on WA-GREET
  - 2017 as the baseline year per regulation
- Pathway applications require operational data from applicant
  - Simplified Tier 1 Calculators
  - Upstream emission data in Tier1 Calculators from WA-GREET

Fuel	Feedstock	Pathway type
WA Gasoline	WA Crude	Lookup Table
Imported Gasoline	MT Crude	
Imported Gasoline	UT Crude	
WA Diesel	WA Crude	Lookup Table
Imported Diesel	MT Crude	
Imported Diesel	UT Crude	
EV Charging	WA Utility	Lookup Table
H2 Fueling	Hydrogen	Lookup Table
Ethanol	Corn/Sorghum	Pathway Application
	Sugarcane	Pathway Application
BD/RD	Various	Pathway Application
Biomethane	OW	Pathway Application
	DSM	Pathway Application
	WWS	Pathway Application
	LFG	Pathway Application
	yes	Pathway Application

2017 Baseline Crude Oil Carbon Intensity Calculations for Washington CFS

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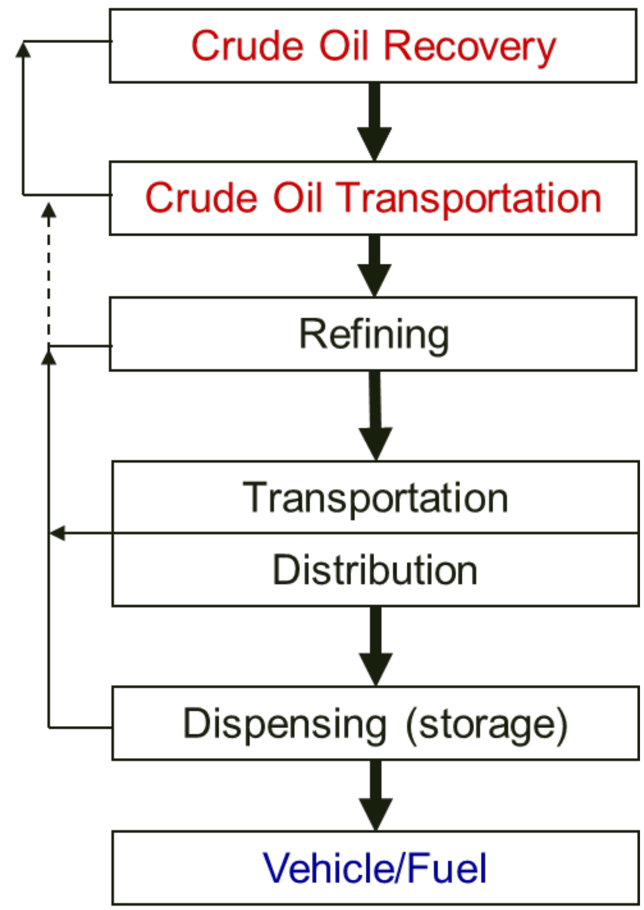
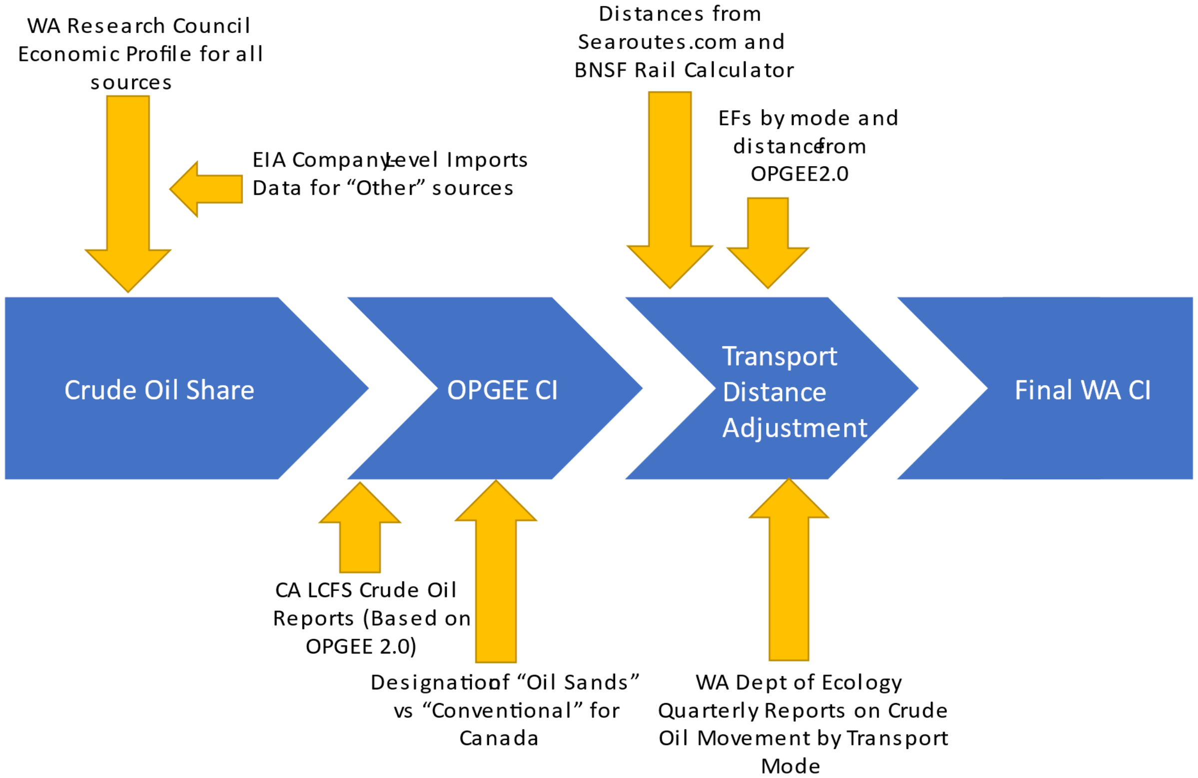
GREET Petroleum

- Crude Oil from OPGEE
- GREET calculates refining
  - Crude oil GHG affects refining



Crude CI Calculation Methodology



Crude CI Calculation Methodology

- Crude Oil Inputs for WA Refineries in 2017
  - WA Research Council Report, Feb 2019
    - All Other Origins – use of EIA Company-Level Import Data for foreign imports into WA

A.3: Origin of Inputs 2017 (KBBLS/Day)	Crude Oil	Other
Alaska	197.8	6.0
Canada (Conventional)	135.9	-
Canada (Oil Sands)	59.5	-
Bakken	133.3	2.0
All Other Origins	45.1	27.6


Washington Research Council Economic Profile

February 2019

The Economic Contribution of Washington State's Petroleum Refining Industry in 2017

ACKNOWLEDGEMENTS

Washington Research Council has produced this report with funding from the Western States Petroleum Association. Washington state's economy is simulated using the Washington Research Council-Regional Economic Models, Inc. (WRC-REMI) model, based on a detailed survey of the five oil refiners operating in Washington. The results of this analysis are the sole responsibility of the Washington Research Council, a nonprofit organization committed to objective analysis of economic and public policy issues in Washington state.

1. Report Overview

This report quantifies the impact of Washington's five major petroleum refiners on the state's economy in 2017.

In 2017, the refiners directly provided 2,171 full-time jobs, paying an annual average wage of $129,132. In addition, the refiners employed, at high wages, 2,658 contract workers on an average day, doing maintenance, capital repair and capital replacement. The refiners indirectly created additional Washington state jobs in industries from which they purchased goods and services, including transportation, construction, utilities and business services. Spending of the income earned in these direct and indirect jobs created even more jobs.

The sum of all these effects was 25,366 jobs and $1.90 billion in personal income for Washington state in 2017. State and local governments received $231.6 million in taxes directly from the refiners and $74.4 million from the follow-on activities of other taxpayers.

Also, industries that distributed refined petroleum products, paid $503 million in wages to 16,078 workers in 2017. Excise taxes collected by the state from these industries totaled $97.3 million in 2017.

Because of Washington's unique tax structure, a Washington refinery's state and local tax burden in 2017 was almost three times higher than the state and local tax burden of a comparable refinery located in California.

The report updates the economic impact analyses of petroleum refining previously prepared by the Washington Research Council (WRC 2004, 2006, 2009, 2010, 2012, 2014 and 2016), drawing upon a survey of Washington refiners conducted by the Council in 2018 (Appendix A) and the WRC-REMI model of the Washington state economy (Appendix C).

Crude CI Calculation Methodology

- Crude Oil Inputs to Washington State Refineries in 2017

Country	Volume, 1000 bbl/day	Share	Mode
US North Dakota	133.3	23.3%	Rail
US Alaska	197.8	34.6%	Vessel
Canada Conventional	135.9	23.8%	Pipeline, Rail
Canada Oil Sands	59.5	10.4%	Pipeline, Rail
Other	45.1	7.9%	Vessel
Brazil		*3.1%*	*Vessel*
Ecuador		*0.4%*	*Vessel*
Mexico		*0.2%*	*Vessel*
Russia		*1.3%*	*Vessel*
Saudi Arabia		*1.6%*	*Vessel*
Trinidad and Tobago		*0.7%*	*Vessel*
Brunei		*0.1%*	*Vessel*
Papua New Guinea		*0.4%*	*Vessel*

Crude CI Calculation Methodology

- CA OPGEE 2.0 CI Values for WA crude sources
  - Volume average multiple fields using CA crude volume data from 2017 CA Crude Oil Average Report for foreign sources (e.g. Brazil, Saudi Arabia, etc.)
  - Brunei and Papua New Guinea not in OPGEE 2.0 – omitted from analysis
- Canada Oil Sands vs Conventional CI
  - Oregon DEQ methodology of including all Canadian fields available in OPGEE 2.0 and simple averaging by crude type
  - Conservative CI calculation in the absence of field-specific data for WA refineries
- Distance Adjustment for WA
  - OPGEE 2.0 emission factors by mode and sea/rail distances between Los Angeles and Seattle

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2017 Crude Average CI Results

- Washington Crude Sources

Country	Share	CA OPGEE2.0 CI, gCO_2/MJ	Transport Adjustment, gCO_2e/MJ	WA CI, gCO_2e/MJ
US North Dakota	23.3%	9.73	-1.03	8.70
US Alaska	34.6%	15.91	-0.16	15.75
Canada Conventional	23.8%	8.40	-0.08	8.32
Canada Oil Sands	10.4%	23.88	-0.08	23.80
Brazil	3.1%	5.86	0.16	6.02
Ecuador	0.4%	9.36	0.16	9.52
Mexico	0.2%	7.51	0.16	7.66
Russia	1.3%	9.39	0.00	9.39
Saudi Arabia	1.6%	9.18	0.16	9.34
Trinidad and Tobago	0.7%	7.41	0.16	7.57
Brunei	0.1%	NA	NA	NA
Papua New Guinea	0.4%	NA	NA	NA
Weighted Average	**100%**	**--**	**--**	**12.57**

2017 Crude Average CI Results

- Montana Crude Sources

Country	Share	CA OPGEE2.0 CI, gCO_2e/MJ
Montana	2%	NA
Wyoming	5%	10.98
Canada	93%	21.41
Weighted Average	**100%**	20.86

- Utah Crude Sources

Country	Share	CA OPGEE2.0 CI, gCO2/MJ
Utah Average	45%	6.03
Colorado	9%	6.81
Wyoming	39%	10.98
Canada	7%	21.41
Weighted Average	**100%**	9.16

Note: Canada Oil Sands vs Conventional CI was weighted based on Alberta crude production data (assumes 84% oil sands)

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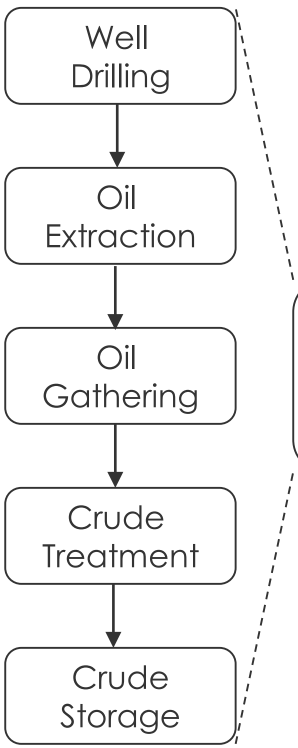
GREET Crude Modelling

- Washington 2017 average crude



Energy Efficiency: 89.9%
112,529 Btu/MMBtu WTT Energy Use

	WA Crude Recovery
Energy efficiency	89.9%
Loss factor	
Shares of process fuels	
Energy ratio of crude oil feeds to product (mmBtu of crude/mmBtu of fuel throughput)	
Crude oil / SCO	0.00%
Residual oil	0.00%
Diesel fuel	0.20%
Gasoline	0.00%
Natural gas	98.99%
Coal	0.00%
Liquefied petroleum gas	0.00%
Electricity	0.78%
Hydrogen	0.00%
Pet coke	0.00%
Diluent flared	
Natural gas flared	
Feed loss	0.03%

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GREET Gasoline Modelling

- Washington only gasoline
  - Based on US gasoline refining in CA-GREET

Crude to Gasoline Refining

Energy Efficiency: 88.6%

	WA Gasoline Blendstock Refining: Feed Inputs
Energy efficiency	88.60%
Loss factor	0.863
Shares of process fuels	
Energy ratio of crude oil feeds	0.863
Crude oil / SCO	0.0%
Residual oil	34.95%
Diesel fuel	0.00%
Gasoline	0.00%
Natural gas	23.61%
Coal	0.00%
Liquefied petroleum gas	0.00%
Electricity	1.51%
Hydrogen	2.38%
Pet coke	0.00%
Butane	24.27%
Blendstock	12.81%
GTL	0.5%

GREET Diesel Modelling

- Washington only Diesel
  - Based on US diesel refining in CA-GREET

Crude to Diesel Refining

Energy Efficiency: 85.87%

	Diesel Refining: Feed Inputs
Energy efficiency	85.87%
Loss factor	0.978
Shares of process fuels	
Energy ratio of crude oil feeds	0.9782
Crude oil / SCO	0.00%
Residual oil	20.86%
Diesel fuel	0.00%
Gasoline	0.00%
Natural gas	71.65%
Coal	0.00%
Liquefied petroleum gas	0.00%
Electricity	3.69%
Hydrogen	3.61%
Pet coke	0.00%
Butane	0.20%
Blendstock	0.00%
GTL	0.00%

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2017 WA-Only Results

- WTW results for gasoline refined in Washington using WA crude
- Does not include petroleum products imported from MT/UT

Gasoline					
g/MMBtu	Crude Recovery and Transportation	Refining	BOB T&D	Total	Final CI, g/M
VOC	2017 Crude Recovery and Transport are modeled by OPGEE	5.08	19.83	24.907	24.91
CO		11.87	0.27	12.138	12.14
CH_4		58.07	0.51	58.588	58.59
N_2O		0.25	0.00	0.256	0.26
CO_2		11,818.80	219.00	12,037.80	12037.80
Convert to gCO_2e/MMBtu		13,381.01	294.50	13,675.51	13675.51
g/MJ	12.57	12.68	0.28	12.96	**99.47**

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WA-GREET Petroleum Results

- Overall Inputs and CI Results for 2017 in WA-GREET
  - Individual state-only results

	Washington-only	Montana	Utah
GREET Simulation Year	2017	2017	2017
Electricity Mix Region	2-WAMX	4-NWPP	4-NWPP
GREET Crude Recovery Efficiency %	89.89%	81.59%	94.07%
GREET Crude CI (g CO_2e/MJ)	12.569	20.860	9.158
GREET Refining Efficiency (%)			
US Gasoline	88.60%	88.60%	88.60%
State Gasoline	88.60%	88.60%	88.60%
US Low Sulfur Diesel	85.87%	85.87%	85.87%
State Low Sulfur Diesel	85.87%	85.87%	85.87%
GREET CI (g CO_2e/MJ)			
Gasoline	99.47	109.61	95.82
Low Sulfur Diesel	100.83	110.02	97.86
Jet	89.98	n/a	n/a

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WA-GREET Petroleum Results

- Washington Weighted Average Results
  - Includes imports from Montana and Utah
  - Import shares based on 2013 data from Department of Ecology

Production Region	Clear Gasoline CI	Gasoline %	Clear Diesel CI	Diesel %	Jet CI
Washington	99.47	83.00%	100.83	84.00%	89.98
Montana	109.61	11.00%	110.02	6.00%	n/a
Utah	95.82	6.00%	97.86	10.00%	n/a
Weighted Average	100.37		101.09		89.98

Electricity Generation in WA-GREET

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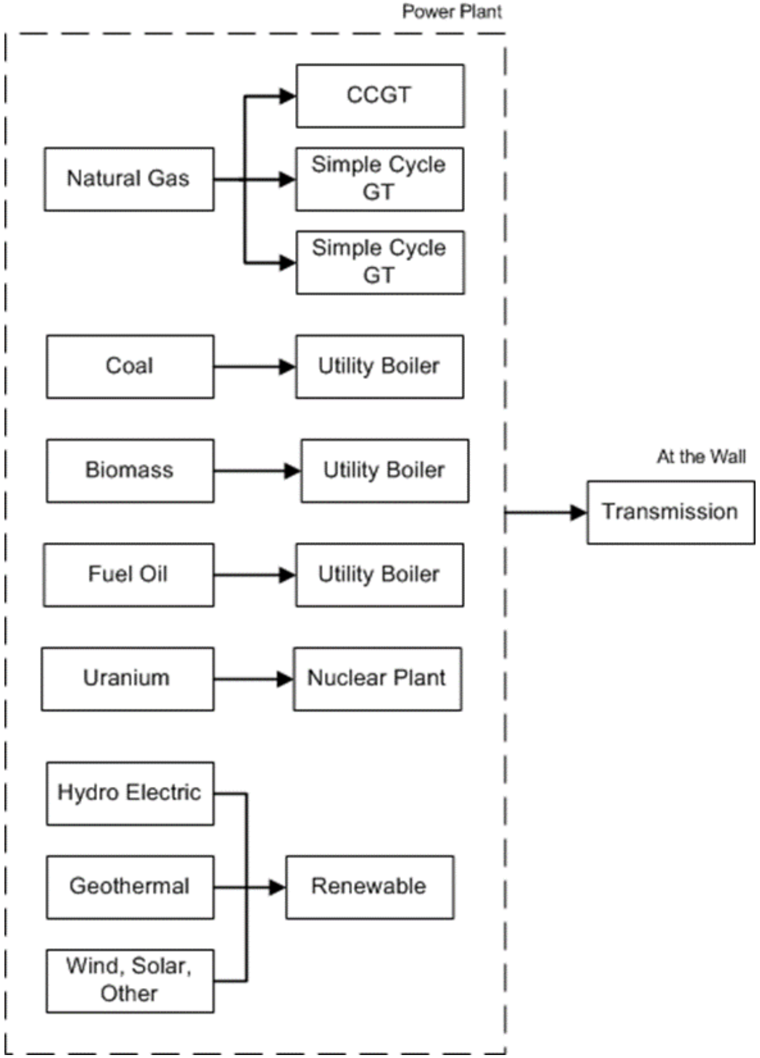
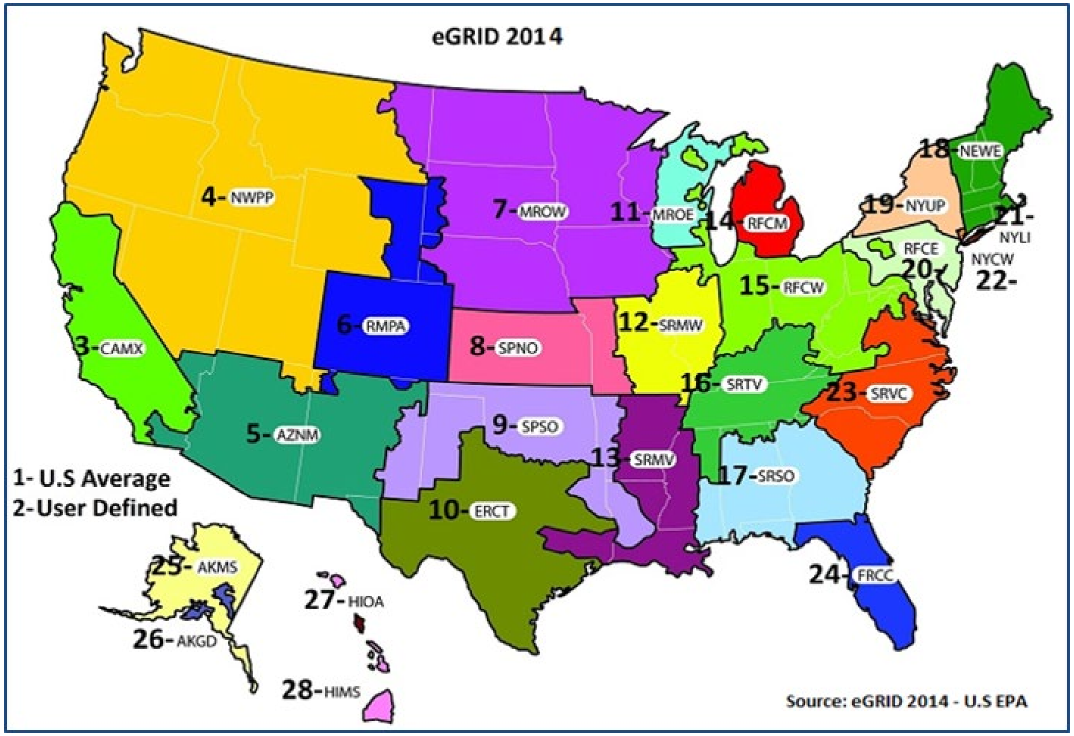
Electricity Generation in GREET

- CA-GREET3.0 uses e-grid 2014v2 regions to differentiate electricity generation mix across different regions
- Well-to-plug GHG emissions calculated on a life cycle basis
  - Added Washington average mix
  - Will also add utility specific mix
- Inputs are resource mix



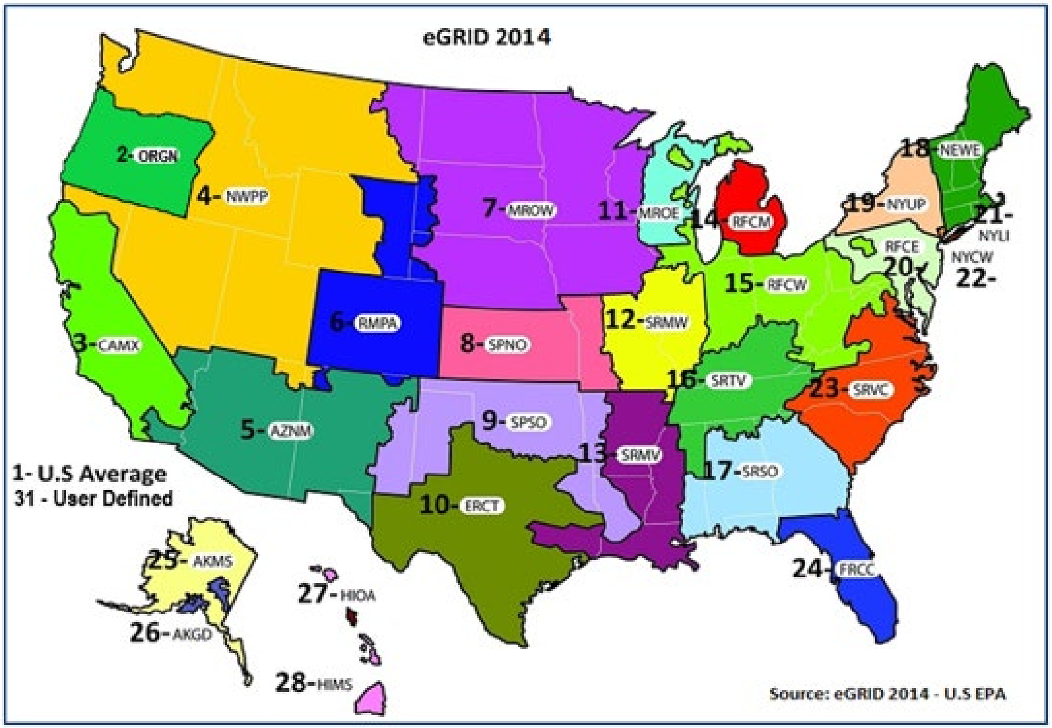
Electricity

- Electricity eGRID regions in CA-GREET3
  - Added to GREET1_2016 by CARB



Electricity

- Electricity regions in OR-GREET



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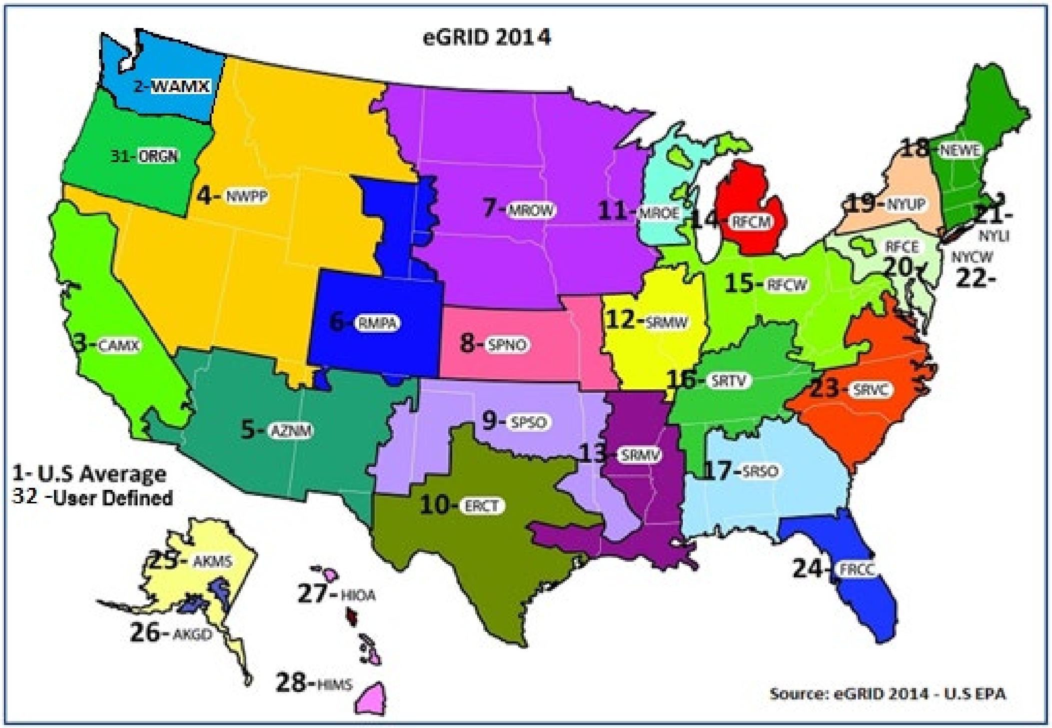
Electricity

- Electricity regions in WA-GREET
  - Retaining ORMX and adding new region for Washington



  - Utility specific mix (within WA) will be added at a future date

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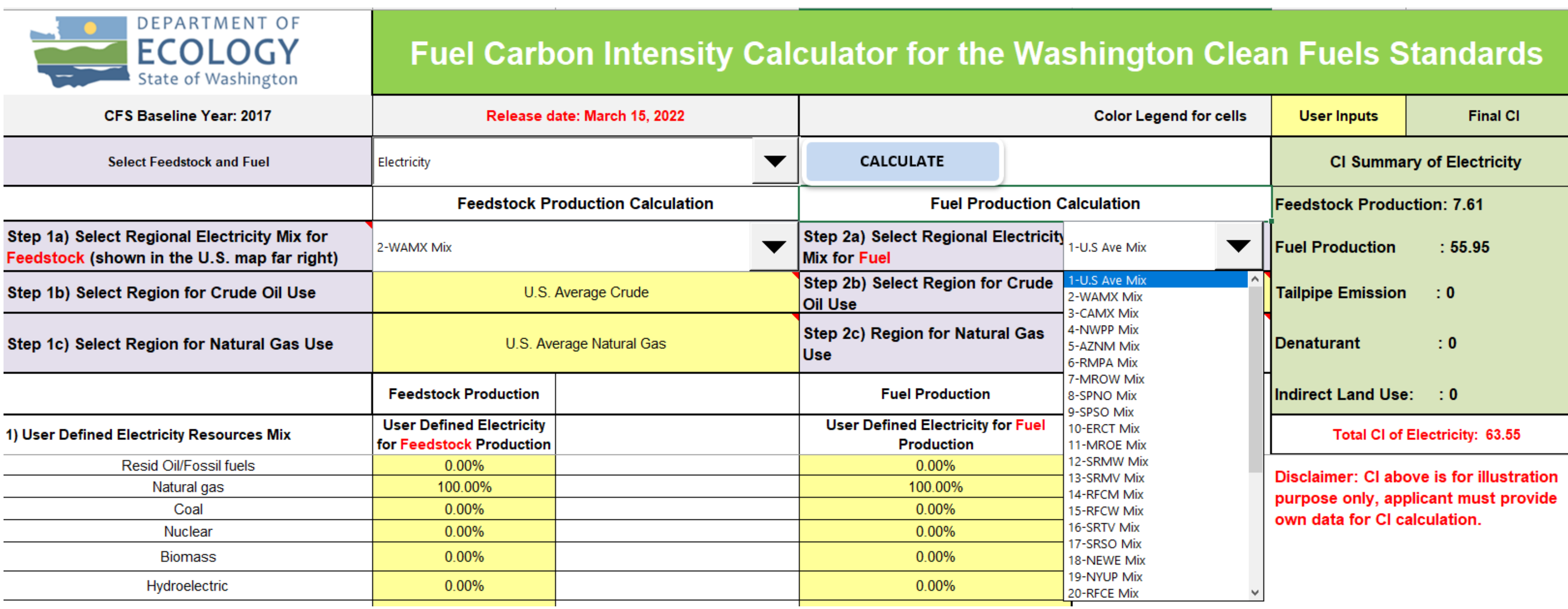
Electricity

- Electricity regions in WA-GREET
  - Pull downs in WA-GREET to select electric grid mix
  - GREET offers separate selection of grid mix for feedstock and fuel phase of a pathway



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Electricity

CA-GREET3.0				OR-GREET3.0				WA-GREET			
1	US Ave	17	SRSO	1	U.S Ave	17	SRSO	1	U.S Ave	17	SRSO
2	User Defined	18	NEWE	2	ORMX	18	NEWE	2	WAMX	18	NEWE
3	CAMX	19	NYUP	3	CAMX	19	NYUP	3	CAMX	19	NYUP
4	NWPP	20	RFCE	4	NWPP	20	RFCE	4	NWPP	20	RFCE
5	AZNM	21	NYLI	5	AZNM	21	NYLI	5	AZNM	21	NYLI
6	RMPA	22	NYCW	6	RMPA	22	NYCW	6	RMPA	22	NYCW
7	MROW	23	SRVC	7	MROW	23	SRVC	7	MROW	23	SRVC
8	SPNO	24	FRCC	8	SPNO	24	FRCC	8	SPNO	24	FRCC
9	SPSO	25	AKMS	9	SPSO	25	AKMS	9	SPSO	25	AKMS
10	ERCT	26	AKGD	10	ERCT	26	AKGD	10	ERCT	26	AKGD
11	MROE	27	HIOA	11	MROE	27	HIOA	11	MROE	27	HIOA
12	SRMW	28	HIMS	12	SRMW	28	HIMS	12	SRMW	28	HIMS
13	SRMV	29	Brazilian	13	SRMV	29	Brazilian	13	SRMV	29	Brazilian
14	RFCM	30	Canadian	14	RFCM	30	Canadian	14	RFCM	30	Canadian
15	RFCW			15	RFCW	31	User Defined	15	RFCW	31	ORMX*
16	SRTV			16	SRTV			16	SRTV	32	User Defined
30 subregions				31 subregions				32 subregions			

*ORMX mix in WA-GREET adopted as-is from OR-GREET3

Electricity

- Washington mix calculation
  - Based on Washington Fuel Mix Disclosure report
    - https://www.commerce.wa.gov/growing-the-economy/energy/fuel-mix-disclosure/
  - Aggregated fuel types to match GREET classification

	GREET Categories								
2018 WA Disclosure	**Residual oil**	**Natural gas**	**Coal**	**Nuclear power**	**Biomass**	**Hydro electric**	**Geothermal**	**Wind**	**Solar PV**
Hydropower						x			
Coal			x						
Cogeneration		x							
Natural Gas		x							
Nuclear				x					
Biomass					x				
Petroleum	x								
Waste	x								
Geothermal							x		
Landfill Gas		x							
Wind								x	
Other	x								
Solar									x
Unspecified		x							

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Electricity

- Washington mix in WA-GREET
  - 2017 mix used for baseline petroleum CI
  - 2018 mix used for biofuel pathway CI calculation
    - Latest Available data

Fuel Type	2018 WA Disclosure	2018 WAMX Mix
Residual oil	0.02%	0.10%
Other	0.05%	-
Waste	0.04%	-
Coal	10.22%	10.22%
Natural gas	7.33%	20.46%
Cogeneration	0.00%	-
Unspecified	12.93%	-
Landfill Gas	0.20%	-
Nuclear power	4.75%	4.75%
Biomass	0.45%	0.45%
Hydroelectric	59.16%	59.16%
Geothermal	0.00%	0.00%
Wind	4.58%	4.58%
Solar PV	0.28%	0.28%

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Electricity

- Well-to-plug results for 2-WAMX mix
- Available on "Electric" sheet in WA-GREET

Average Electricity from	2-WAMX Mix						2-WAMX Mix	
Details Breakdown of CI for Electricity Resources	Residual Oil	NG	Coal	Biomass	Nuclear	Total, g/MMBtu	Electricty Prod For Stationary Use	Final CI, g/MJ
VOC	0.02	4.70	2.37	0.02	0.04	7.15	1.63	
CO	0.04	14.62	0.94	0.09	0.18	15.87	21.19	
CH4	0.51	118.32	46.86	0.10	0.23	166.03	1.48	
N2O	0.00	0.65	0.01	0.00	0.00	0.66	0.67	
CO2	30	3,010	485	44	63	3,632	58,752	
Convert to $gCO_2e/MMBtu$	43	6,198	1,668	47	70	8,026	59,026	
g/MJ	0.04	5.87	1.58	0.04	0.07	7.61	55.95	**63.55**

Tier 1 Simplified Calculators for WA-GREET

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Tier1 Simplified Calculators

- WA adopted tier1 simplified calculators developed by CARB for California LCFS
  - Tier 1 refers to biofuel pathways with relatively low complexity
- Intended to simplify access to carbon intensity calculation
  - External to WA-GREET
- Require monthly operational data to calculate the pathway CI
  - Combine operational data with the life cycle emission factors derived from WA-GREET
- Each calculators accommodates a specific type of biofuel pathway(s)

Tier1 Simplified Calculators

- List of simplified calculators available:
  - Starch and Fiber Ethanol
  - Sugarcane-derived Ethanol
  - Biodiesel and Renewable Diesel
  - LNG and L-CNG from North American Fossil Natural Gas
  - Biomethane from North American Landfills
  - Biomethane from Anaerobic Digestion of Wastewater Sludge
  - Biomethane from Anaerobic Digestion of Dairy and Swine Manure
  - Biomethane from Anaerobic Digestion of Organic Waste
- Consistent with CA LCFS and OR CFP
- Emission factors available on "EF Tables" sheet
  - Based on US-Average grid mix unless specified

Tier1 Simplified Calculators

- Example: Starch and Fiber Ethanol Calculator
  - CI Results section of “EtOH” sheet

Tier 1 Simplified CI Calculator for Starch and Fiber Ethanol

Pathway Summary and Estimated CI (g/MJ)					
Corn Ethanol Composite CI, g/MJ	0.00	Sorghum Ethanol (Composite CI), g/MJ	0.00	Corn/Sorghum Fiber Ethanol CI, g/MJ	0.00
Denatured Volume, gal	0	Denatured Volume, gal	0	Denatured Ethanol Volume, gal	0
Corn Ethanol (Dry DGS) CI, g/MJ	0.00	Sorghum Ethanol (Dry DGS) CI, g/MJ	0.00		
Denatured Volume, gal	0	Denatured Volume, gal	0		
Corn Ethanol (Modified DGS) CI, g/MJ	0.00	Sorghum Ethanol (Modified DGS) CI, g/MJ	0.00		
Denatured Volume, gal	0	Denatured Volume, gal	0		
Corn Ethanol (Wet DGS) CI, g/MJ	0.00	Sorghum Ethanol (Wet DGS) CI, g/MJ	0.00	CALCULATE CI	
Denatured Volume, gal	0	Denatured Volume, gal	0		

Section 1. Applicant Information			
1.1. Company Name		1.2. Application Number	
1.3. Company ID			
1.4. Facility ID			
1.5. Ethanol Production Location (City, State)		1.6. Application Description	
1.7. Electricity Mix Region for Feedstock	1-U.S Ave Mix		
1.8. Provisional Pathway?	No		

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Tier1 Simplified Calculators

- Example: Starch and Fiber Ethanol Calculator
  - Section of "EF Tables" sheet

Greenhouse Gases Emissions Factors Used in WA-GREET for Carbon Intensity Calculations
(see "WA-GREET for EF Table")

GHG Emission Factors	1-U.S Ave Mix	2-WAMX Mix	3-CAMX Mix	4-NWPP Mix	5-AZNM Mix	6-RMPA Mix	7-MROW Mix	8-SPNO Mix	9-SPSO Mix	10-ERCT Mix	11-MROE Mix
Emissions from Electricity use (gCO2e/kWh)	578.82	228.8	368.98	476.16	459.17	852.20	684.29	793.26	796.11	638.37	893.56

Non-combustion (gCO2e/MJ)	0.09
Enzymes and Yeast (gCO2e/MJ)	**2.02**
Natiral Gas for Ethanol Production (g CO2e/MMBtu)	73,365
Natiral Gas for Drying DGS (g CO2e/MMBtu)	73,352

Corn Farming, Fertilizers, N2O in soil

	Farming	Fertilizers	N2O in soil	Total, gCO2e/bushel
VOC	0.51	2.61		
CO	4.19	3.18		
CH4	1.84	5.89		
N2O	0.02	0.78	10.70	
CO2	618.72	2166.87		
Total, gCO2e/bushel	678.39	2558.41	3188.43	6425.23

Sorghum Farming, Fertilizers, N2O in soil

	Farming	Fertilizers	N2O is soil	Total, gCO2e/bushel
VOC	0.91	2.84		
CO	7.42	3.67		
CH4	2.17	7.03		
N2O	0.02	0.86	11.61	
CO2	956.07	2332.26		
Total, gCO2e/bushel	1031.29	2777.62	3458.85	7267.76

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Indirect Land Use Conversion for Washington Clean Fuels Standard

Stefan Unnasch

March 10, 2022

Outline

- iLUC Principles
- iLUC GHG Emissions
- Recommendations

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Indirect Land Use Conversion

- Feedstocks are part of agro-economic system
- Diversion of feedstocks to consumer goods or fuels will affect global markets
  - Eat less, wear polyester clothing, shift food types –beef to chicken
  - Convert land to grow crops, release carbon from land conversion
  - Improve crop yields due to price signals
- iLUC is viewed as a macro economic or displacement phenomenon
- Evolution of estimates

Direct and Indirect Land Use

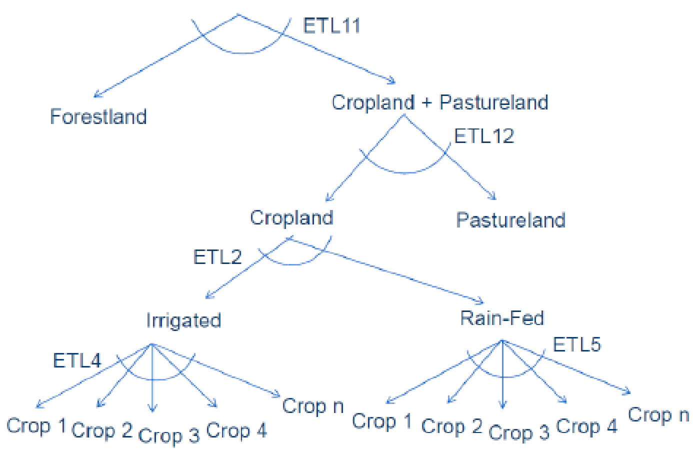
- dLUC often referred to as net carbon balance for cropping system
  - Soil carbon changes
  - Direct conversion of land to grow new crop (if measurable)
- iLUC analysis
  - Responds to demand in commodity crops
  - dLUC and iLUC are combined
  - All of the land conversion is indirect, forest, pasture, conservation reserve program
  - Even if you know the source of your crop, it doesn't matter
    - Ø iLUC is a displacement effect

iLUC Analysis

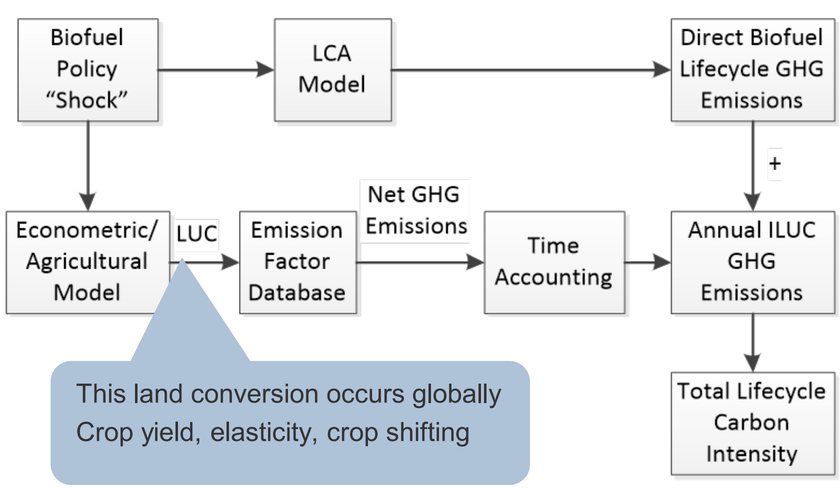
- Regulators have incorporated iLUC into CA and OR LCFS as well as Federal RFS
- Combine carbon stocks with predicted land conversion

Crop use Shock

Land Transformation Tree



iLUC Analysis



ILUC Modeling Efforts

- Modeling efforts and applications of iLUC
  - EPA RFS2
  - CARB 2009
  - CARB 2014
  - Purdue/ANL GTAP
  - Oregon 2018
- Downward trend in iLUC is the result of better development, calibrated economic models, and revised data (Wang, 2021)
- GREET CCLUB has developed GHG emissions results from GTAP iLUC results

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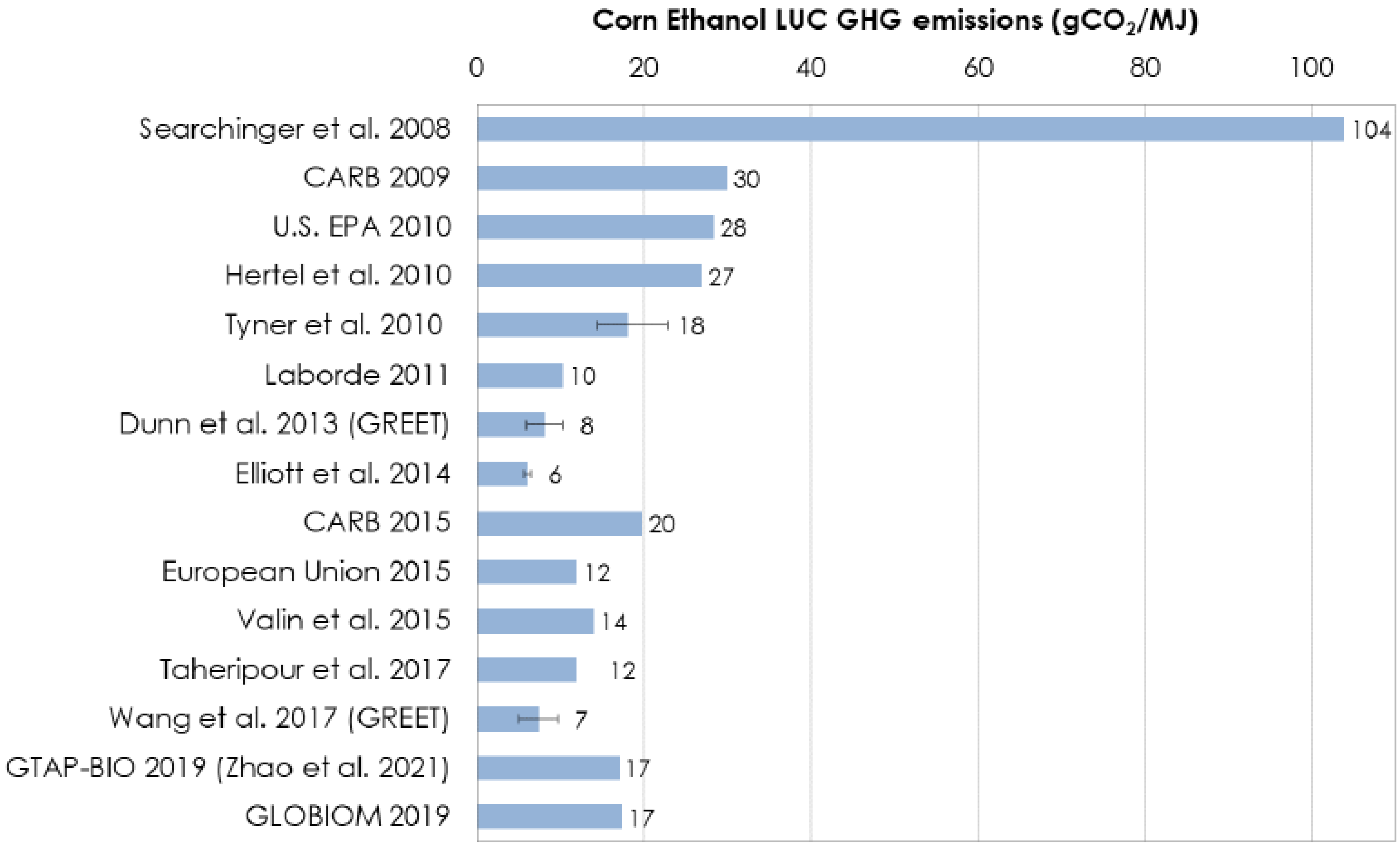
Corn Ethanol iLUC Progression



Source: Wang, 2021

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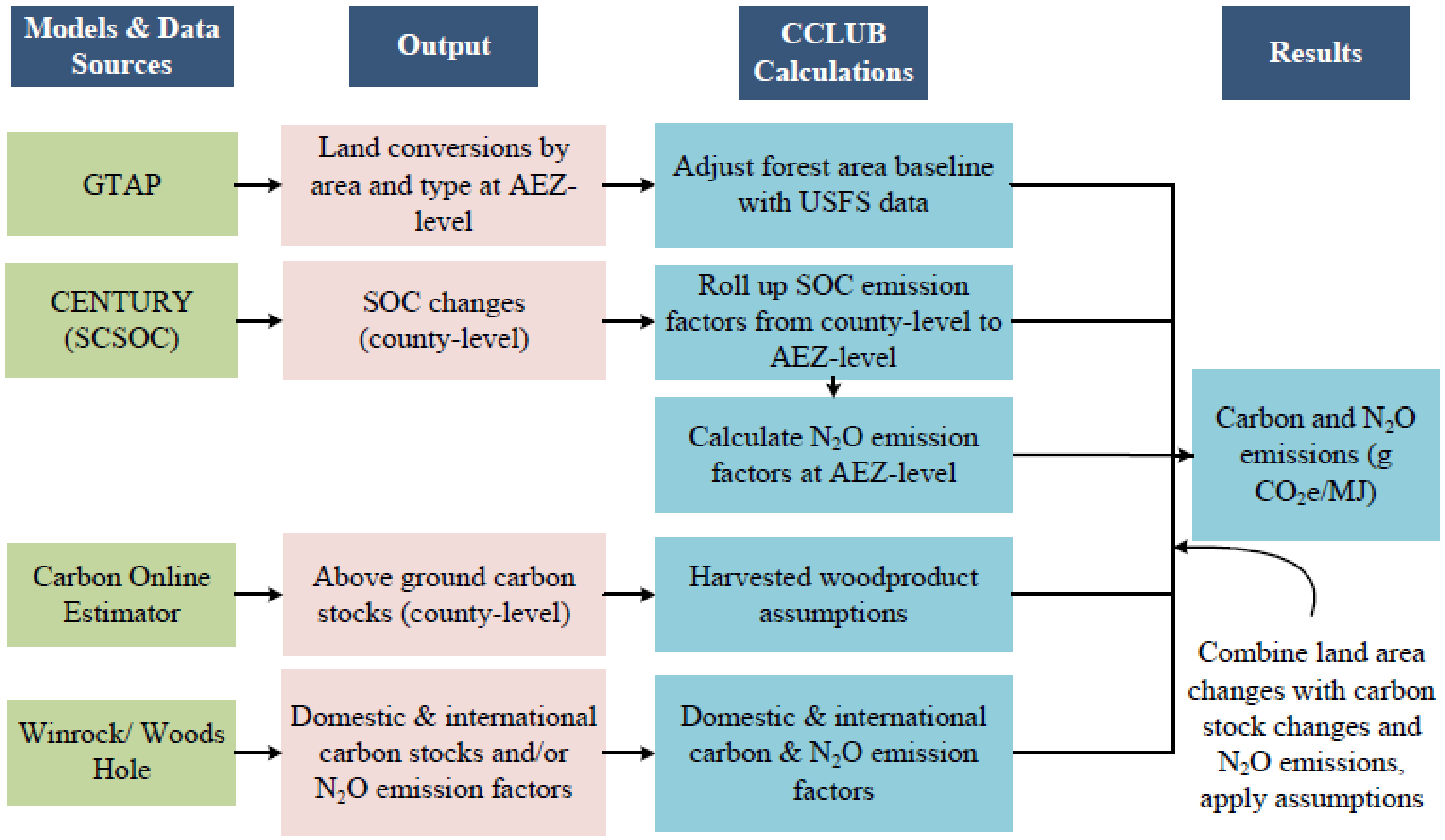
CCLUB Approach



Source: CCLUB Manual; Kwon, 2020

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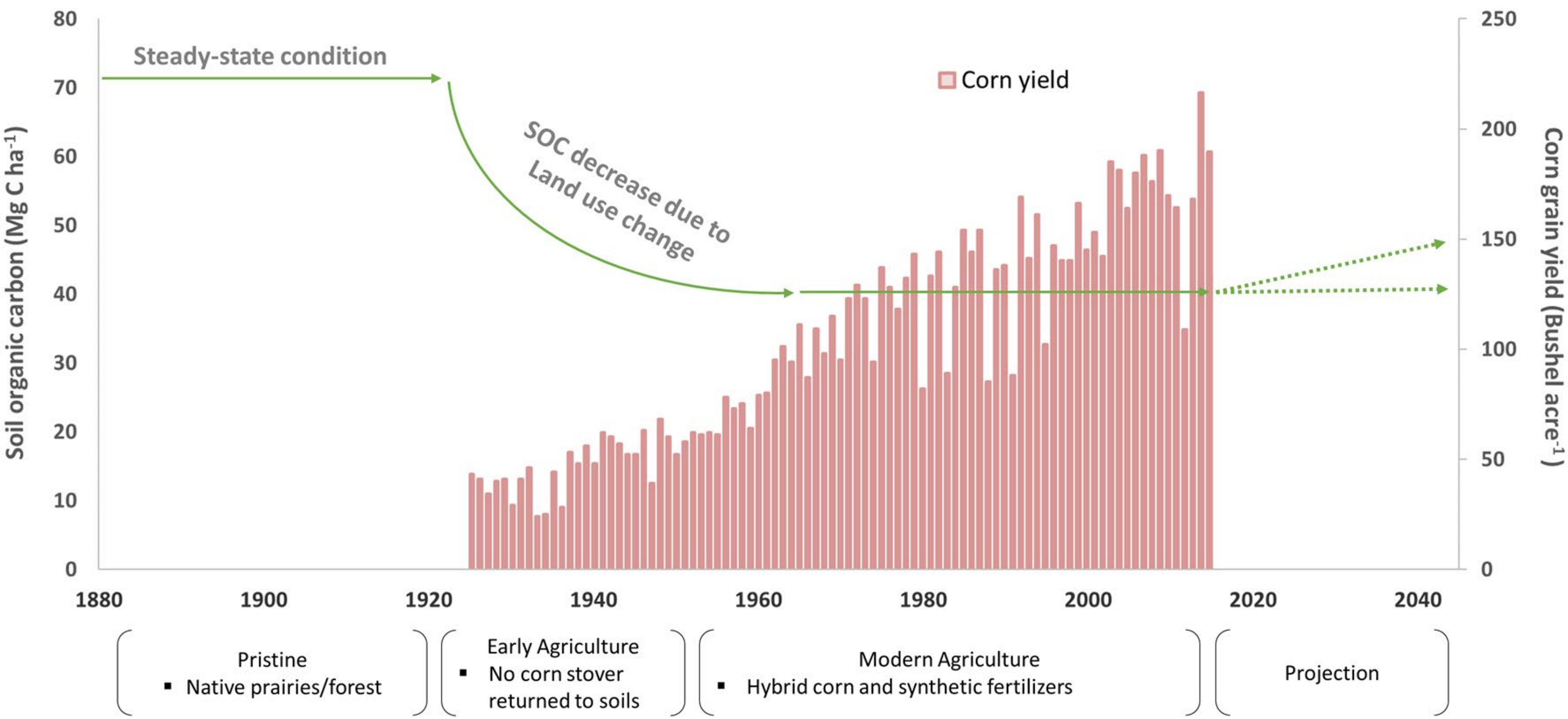
Argonne's SOC Modeling

- Employ a parameterized version of the process-based CENTURY model
  - Coupling CENTURY with spatiotemporal model input data
  - Generate feedstock- and county-level SOC changes for the United States
- Simulations of SOC dynamics are driven by
  - Crop-residue carbon inputs that are empirically calculated using observed crop yields, agronomic indices, and crop carbon composition
  - SOC decay rate adjustments that reflect the influence of climatological, physical (e.g., tillage or other field operations), and inputs (e.g., fertilizer applied or residues returned) factors
- Run simulations over a long-term period
  - With an assumed land-use history and model inputs

Source: Kwon, 2021

Long-Term Dynamic SOC Stocks

- Simulation over baseline and alternative scenario



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CCLUB Carbon Stock Data

	Scenario sa_30 cm							
Scenario#	1	2	3	4	5	6	7	8
Scenario	Corn and Corn Stover							
Historic land use	Pasture/hay/grasslands							
1880-1950	croplands							
1951-2010	croplands							
2011-2040	Corn-corn							
	Conventional tillage		Reduced tillage		No tillage		US Average	
Residue or biomass removal rate (%)	0.0	30.0	0.0	30.0	0.0	30.0	0.0	30.0
Carbon inputs	None	None	None	None	None	None	None	None
AEZ7	0.43	0.30	0.47	0.33	0.57	0.42	0.48	0.34
AEZ8	0.30	0.19	0.34	0.22	0.42	0.30	0.35	0.23
AEZ9	0.29	0.17	0.32	0.20	0.42	0.29	0.34	0.21
AEZ10	0.27	0.15	0.31	0.18	0.37	0.25	0.32	0.19
AEZ11	0.23	0.12	0.26	0.15	0.32	0.21	0.27	0.16
AEZ12	0.16	0.09	0.17	0.11	0.23	0.16	0.18	0.12
AEZ13	0.82	0.62	0.87	0.67	0.95	0.75	0.87	0.68
AEZ14	0.54	0.39	0.58	0.43	0.65	0.50	0.59	0.44
AEZ15	0.38	0.25	0.42	0.29	0.49	0.36	0.42	0.30
AEZ16	0.38	0.25	0.42	0.29	0.49	0.36	0.42	0.30
Natl. Average	0.28	0.18	0.30	0.21	0.36	0.27	0.31	0.22

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CCLUB Corn Ethanol GTAP 2011

LUC Emissions	Forest	Grassland	Cropland-Pasture	Young Forest-Shrub	Sum
Carbon Emissions					
--Domestic Emissions	4.2	-0.9	-1.9	0.5	1.9
--International Emissions	0.0	3.1	2.0	0.0	5.0
				Total	7.0
N2O & CH4 Emissions					
--Domestic Emissions	0.1	0.0	0.0	0.0	0.1
--International Emissions	0.1	0.0	0.2	0.0	0.3
				Total	0.4
Total GHG Emissions					
--Domestic Emissions	4.3	-0.9	-1.9	0.5	2.0
--International Emissions	0.1	3.1	2.2	0.0	5.4
				Total	7.4

iLUC Controversy

- Debates on all topics
  - Elasticity factors
  - Emission factors
  - Deforestation

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iLUC References

Wang, M., U. Lee, H. Kwon, and M. Wu (2021). Retrospective Analysis of U.S. Corn Ethanol GHG Emissions for 2005 – 2019. 2021 Fuel Ethanol Workshop, De Moines, IA.

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Taheripour, F., Mueller, S., & Kwon, H. (2021). Response to "how robust are reductions in modeled estimates from GTAP-BIO of the indirect land use change induced by conventional biofuels?". Journal of Cleaner Production, 310, 127431.

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iLUC Summary and Recommendations

- Consistency, best science, logic

		Ethanol				Biodiesel/ Renewable Diesel			
Study	**Model**	**Corn**	**Sorghum**	**Sugarcane**	**Corn Stover**	**Soy**	**Canola**	**Palm**	**Carinata**
iLUC (g CO_2e/MJ Fuel)									
EPA 2010	FASOM/FAPRI	26.3	28.0	5.1		31.9			
CARB 2009	GTAP BIO	30	45	46		42		N/A	
CARB 2014	GTAP BIO ADV	19.8	19.4	11.8		29.1	14.5	71.4	
OR LCFS	GTAP BIO ADV	7.6	19.4	11.8	0	29.1	14.5		
ANL 2018	CCLUB GTAP 2011	7.4				7.9			
ANL 2018	CCLUB GTAP 2013	3.9							
		ATJ	**ATJ**	**ATJ**	**ATJ**	**SPK**	**SPK**	**SPK**	**SPK**
CORSIA	GTAP BIO ADV	22.1		7.3		27	24.1	39.1	-21.4
Recommended WA CFS		**7.6**	**7.6**	**11.8**	**0**	**29.1**	**14.5**	**71.4**	**0**

ATJ = Alcohol to Jet, SPK = Synthetic Paraffinic Kerosene

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5-Minute Break

Comments and Questions

Please be brief
so everyone has a chance to comment.

DEPARTMENT OF ECOLOGY
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Draft Rule Overview

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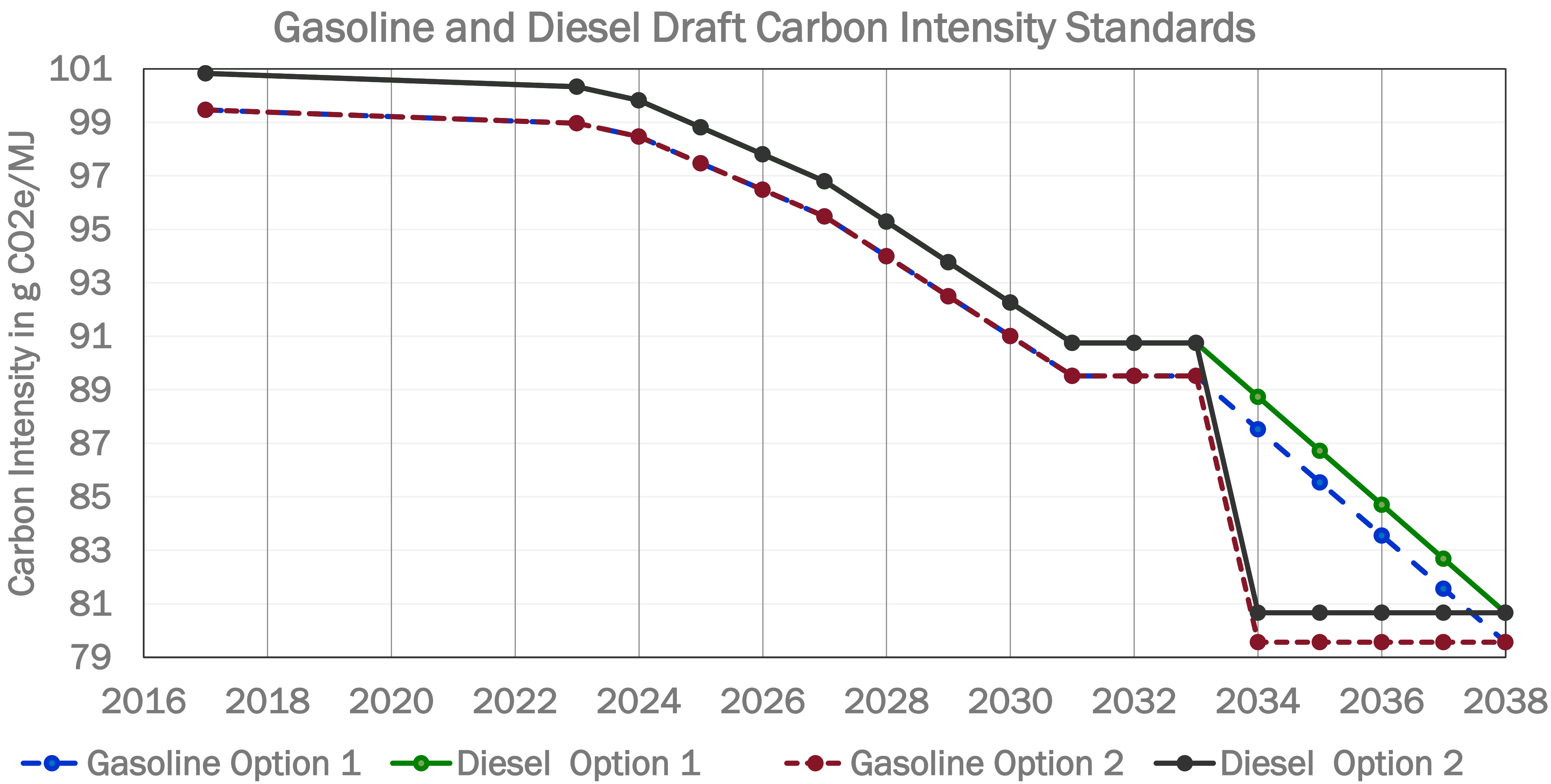
Carbon Intensities

- WA-GREET or Ecology approved model
- **Reviews CI** – every three years or sooner
- **Lookup Tables:** gasoline; diesel; fossil NG & LPG; electricity & H_2
- **Utility-specific CI –** every January 15
- **CARB or OR-DEQ approved FPW –** adjust to match WA-GREET
- **Alternative fuel pathway application:**
  - Tier1: well established fuel pathways – conventional feedstocks
  - Tier2: newer fuel pathways – starts July 1, 2025
- **Specified source feedstocks** – lower CI
- **Fuel producer –** sets maximum CI
- **Fuel producer labeling:** actual CI $\leq$ certified CI

Draft Carbon Intensity Standards



Draft baseline CI: gasoline = 99.46 g CO2e/MJ, diesel = 100.83 g CO_2e/MJ

- Option 1: 2% reduction/year 2034-38; Option 2: 10% reduction in 2034

Obtaining a Carbon Intensity

1. Process to use CI approved by CARB or OR-DEQ
2. Information to use Tier 1 and Tier 2
3. Information for Tier 1 applicants
4. Information for Tier 2 applicants
5. Provisional CI: 90 days – 24 months
6. Biogenic feedstock co-processing at refinery
7. Temporary fuel pathway codes for indeterminate Cis
8. CI approval process for fuels other than electricity
9. Fuel pathway approval process
10. Application completeness determination
11. Additional substitute & temporary FPW Codes
12. Measurement accuracy
13. Missing Data provision

Energy Economy Ratio - Adjusted CI

1. Application – modified Tier 2
2. Eligibility: vehicle manufacturers, owners, or operators
3. Onboard batteries or fuel cells
4. Application requirements for EER-adjusted CI
5. Minimum data requirements
6. Application review process
7. Adding joint applicants after CI value approval
8. Ongoing reporting requirements
9. Modifications to issued CI values

Determining Carbon Intensity of Electricity

1. Utility-Specific electricity mix: fuel-mix disclosure
2. Statewide electricity CI: fuel mix disclosure
3. Unspecified electricity – natural gas
4. On-site renewable electricity – documentation
5. Off-site renewable electricity – RECs
6. CI for renewable electricity
   1) Zero CI for solar, wind, geothermal, hydropower, and ocean power
   2) Tier 1 or Tier 2 appl. for biomass, biogas, biodiesel, and hydrogen
7. Utility Renewable Electricity Products and Power Purchase Agreements – Tier 2 application

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Next Steps & Wrap Up

Rachel Assink

Stakeholder Meetings and Comments

Next stakeholder meeting:

April 13, 2022 (9 a.m. – noon)

- Carbon intensity calculation update
- Peer review of carbon intensity calculation
- Program fee structure

End of informal public comment period:

April 25, 2022

Comment online and read others' comments:
https://aq.ecology.commentinput.com/?id=DpgZ3

Summary of stakeholder meeting will be posted on the Clean Fuels Program rulemaking web page [1]

[1] https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/ Rulemaking/WAC-173-424-455

For More Information

Learn More

- Visit the rulemaking web page: https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/Rulemaking/WAC-173-424-455

Stay Informed

- Join the email list: https://public.govdelivery.com/accounts/WAECY/subscriber/new?topic_id=WAECY_142

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Thank you