BUREAU OF ENERGY AND TECHNOLOGY POLICY

Slides for the morning and afternoon sessions are in separate decks. This is the **afternoon** deck.

December 15, 2022

Market-Based Decarbonization Programs & Low-Carbon Incentives

Technical Session 8
CT 2022 Comprehensive Energy Strategy

Session is being recorded

Today's Agenda – Morning

Slides for the morning session are in a separate deck

Welcome & Introduction	9:00-9:10 am
Public Comment	9:10-9:30 am
Topic Introduction	9:30-10:00 am
Policy Recommendations Received through Prior CT Processes	10:00-10:35 am
What Other States are Doing	10:35-11:45 am
Q&A	11:45-12:00 pm
----------LUNCH----------	12:00-1:00 pm

BUREAU OF ENERGY AND TECHNOLOGY POLICY

Today's Agenda – Afternoon

Click on an agenda section heading to jump to the relevant slides

What Other States are Doing Continued	1:00-1:55 pm
Q&A	1:55-2:10 pm
Proposals for CT's Path Forward	2:10-3:45 pm
Q&A	3:45-4:00 pm
Public Comment	4:00-4:20 pm
Wrap Up	4:20-4:30 pm

What Other States are Doing Continued

David Chu – CT Energy Marketers Association (CEMA)

Carolyn Berninger – Great Plains Institute (GPI)

Floyd Vergara & Veronica Bradley – Clean Fuels Alliance America (CFAA)

Dr. Farzad Taheripour – Purdue University

(speaker order may vary)

Click on an agenda section heading to jump to the relevant slides

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CT Energy Marketers Association (CEMA)

Market-based Emissions Trading Systems

DAVID CHU, VICE PRESIDENT, CONNECTICUT ENERGY MARKETERS ASSOCIATION

Emissions Trading Systems

- Cap-and-Trade Systems

  Apply a cap on emissions within the ETS through emissions allowances

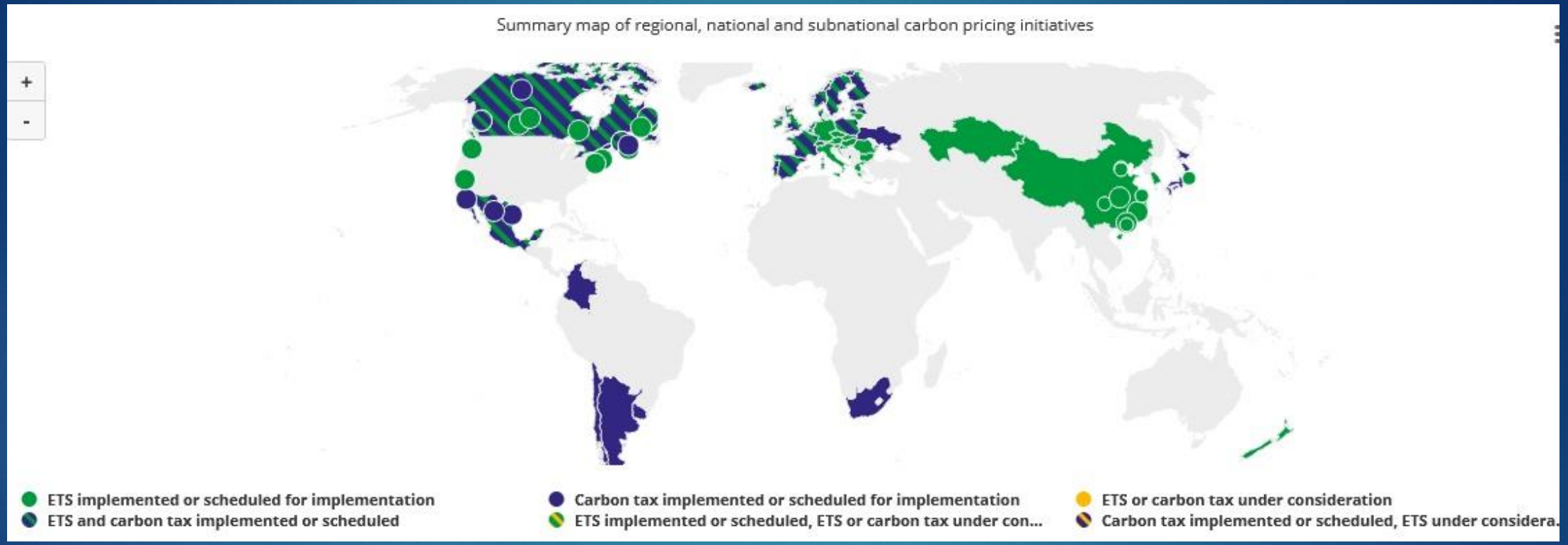
- Credit Systems

  Credits issued to entities that reduce emissions below a baseline

Non-ETS Pricing

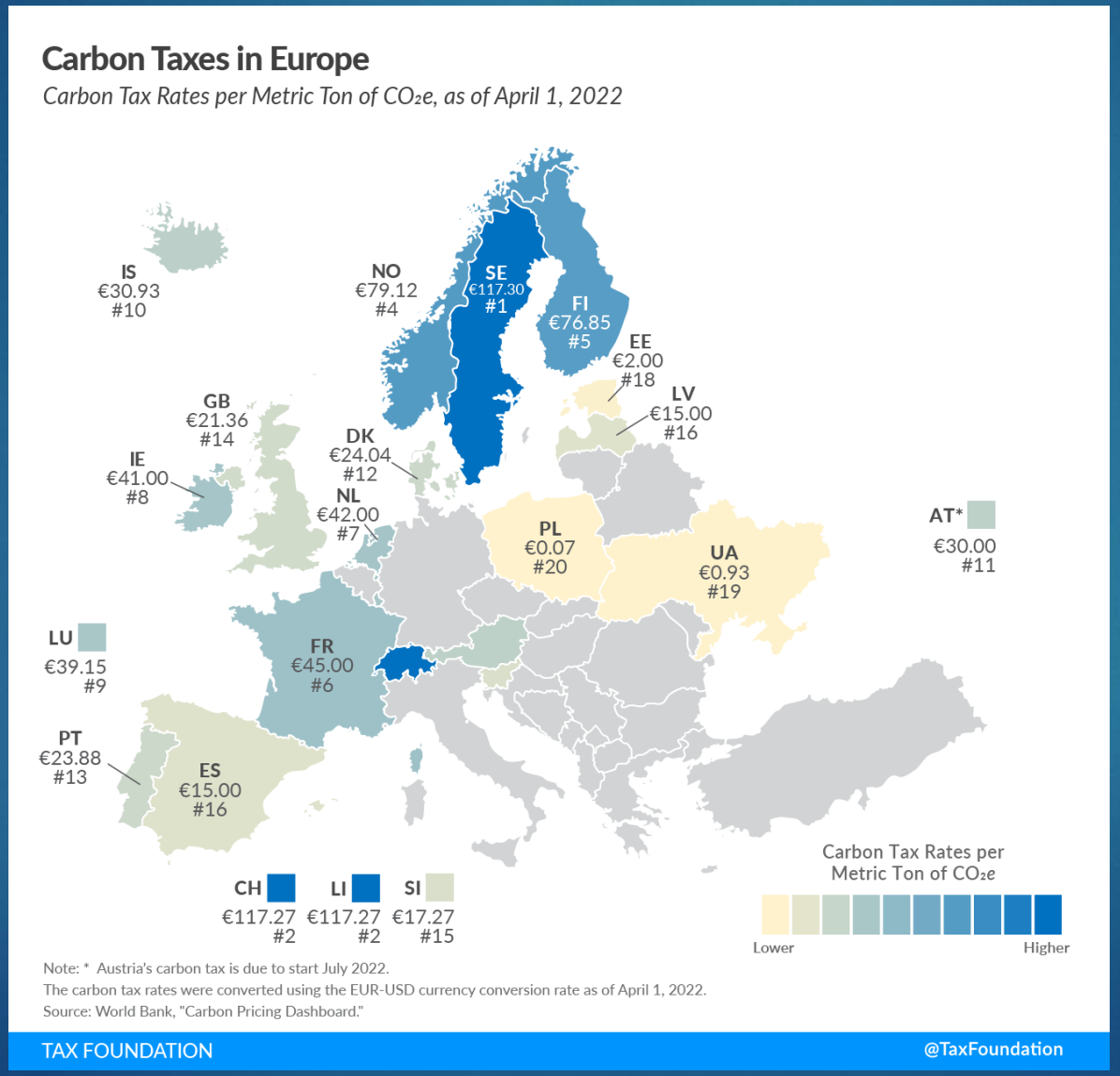
- Carbon Taxes
- Crediting Mechanisms
- Results-Based Climate Financing
- Internal Carbon Pricing

Carbon Pricing Globally



EU has the oldest and largest ETS for GHG emissions worldwide. They also have carbon taxes.

EU Carbon Taxes



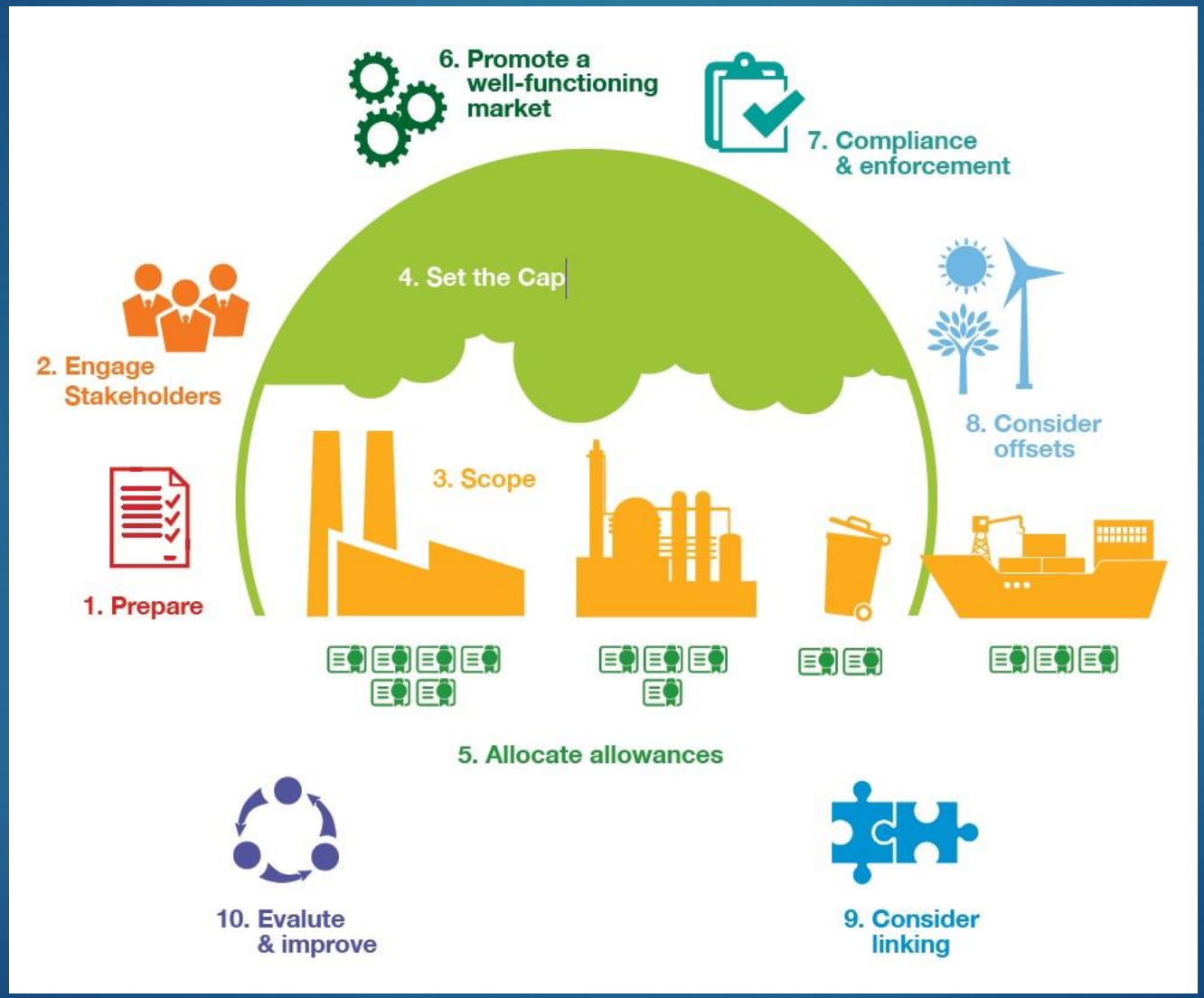
U.S. ETS's

East Coast is RGGI
West Coast: California Cap-and-Trade; Oregon Climate Protection Program

ETS Examples

STRUCTURE AND PRACTICE

ETS Structure



Example 1: Eastern U.S.

TRANSPORTATION &
CLIMATE INITIATIVE

Key Features

- Declining cap on allowances
- Purchase of allowances by obligated parties at auctions
- Auction price stability mechanisms
- Allowances can be sold on the secondary market
- Availability of limited offsets

TCI Auction Example

RGGI / TCI Differences

RGGI

- Few obligated parties
- Alternatives to buying allowances
- Orderly auctions
- Stable secondary market
- Prices to consumers regulated

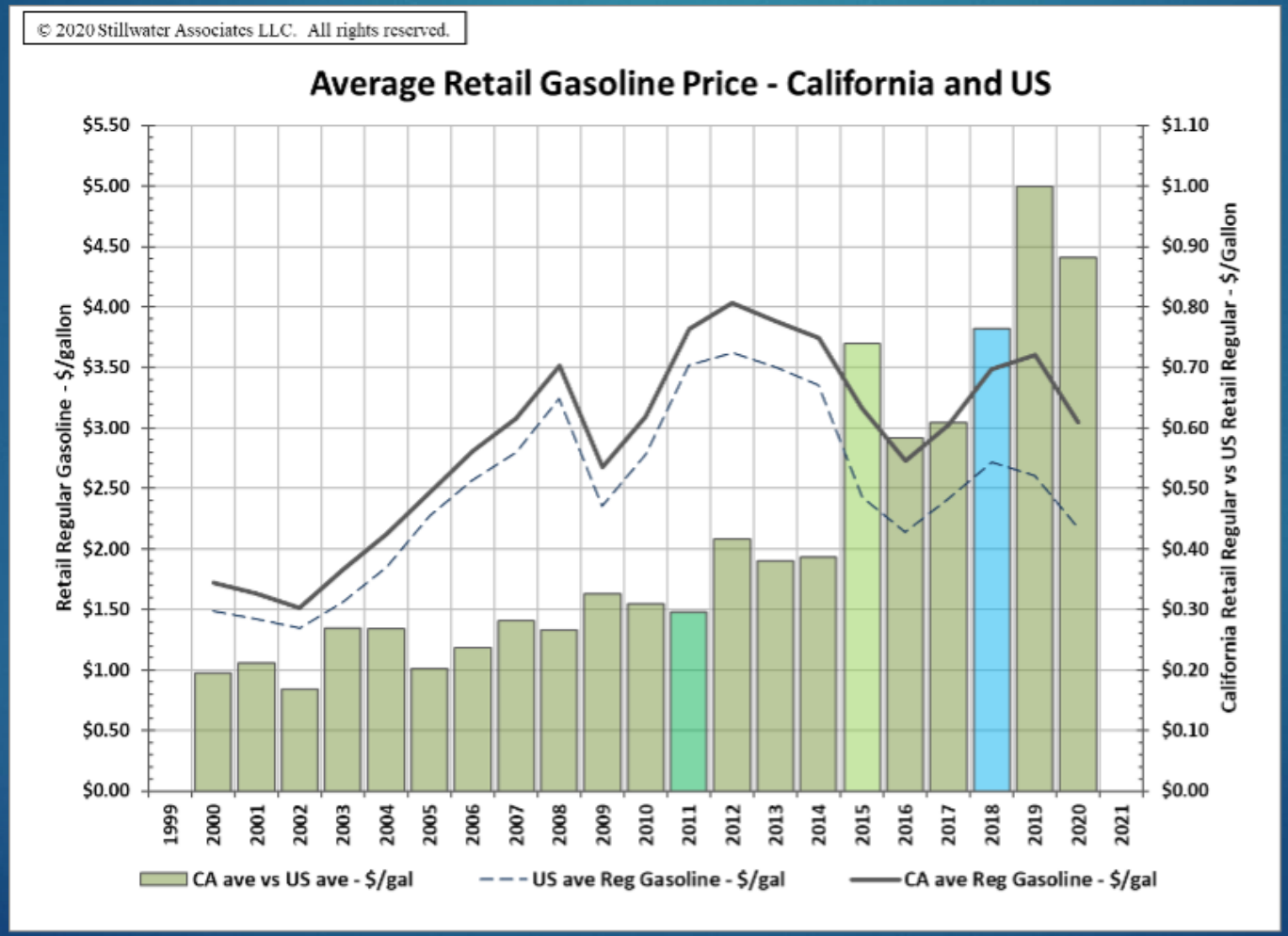
TCI

- Many obligated parties
- No alternative to allowances
- Potentially chaotic auctions
- Potential anti-competitive behavior
- All costs passed on to consumers

Example 2: California

- Low-Carbon Fuel Standard (LCFS)
- Cap and Trade

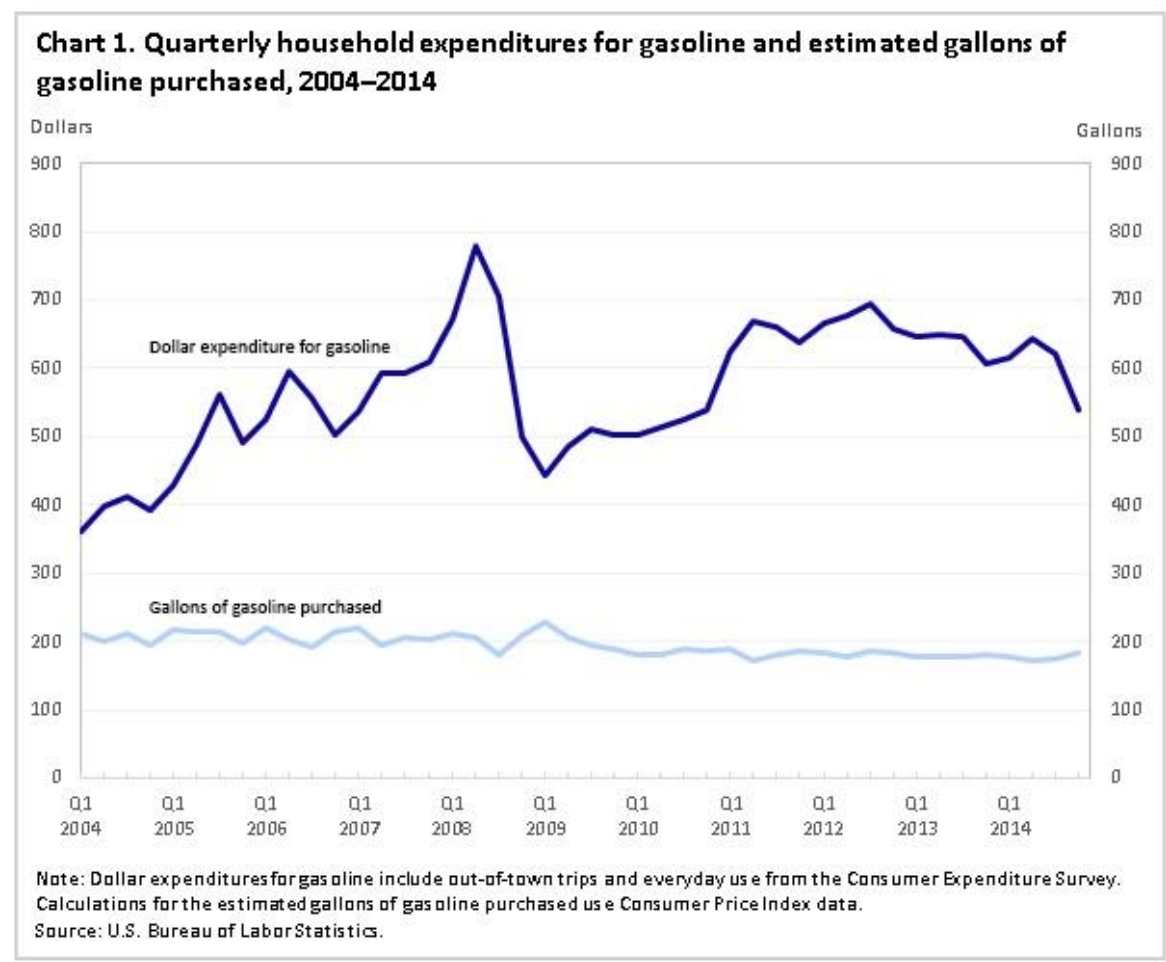
LCFS and C&T Contribute to CA Gas Prices



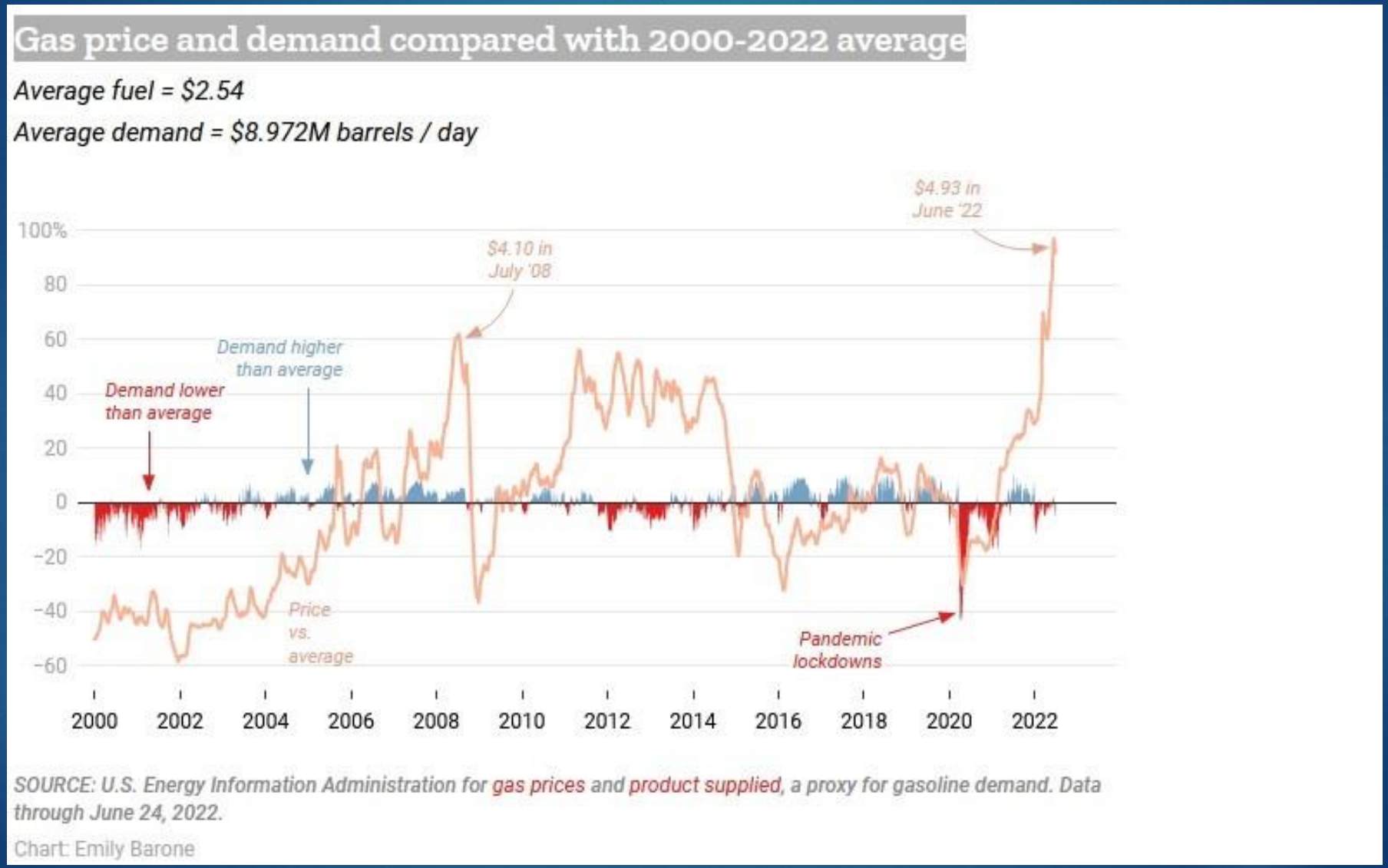
ETS & Pricing Mechanism Effect on Consumer Consumption

GASOLINE PRICE ELASTICITY IS KEY

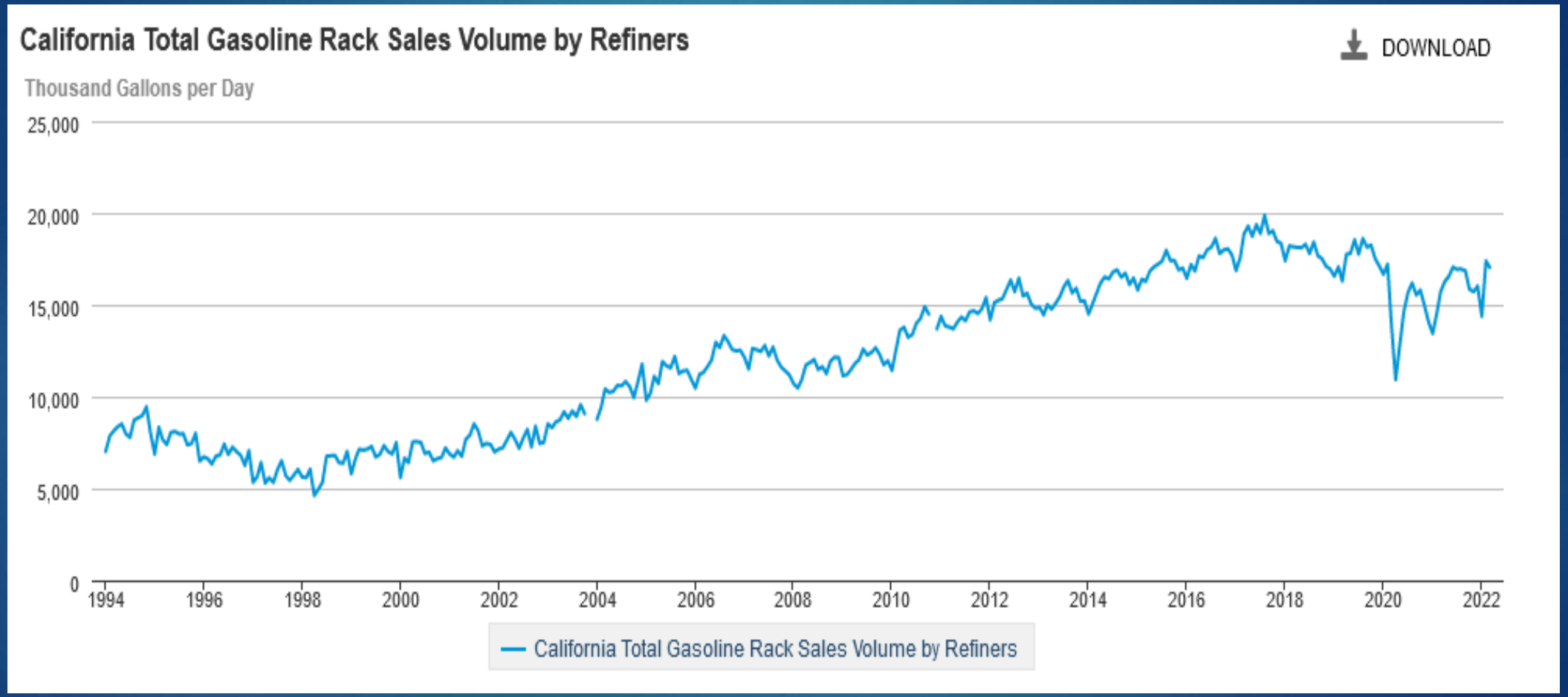
U.S. Gasoline Inelasticity



U.S. Gas Price vs. Demand



California Gasoline Sales



Great Plains Institute (GPI)

Clean Fuels Policy Efforts in Midwest States

Great Plains Institute

December 2022

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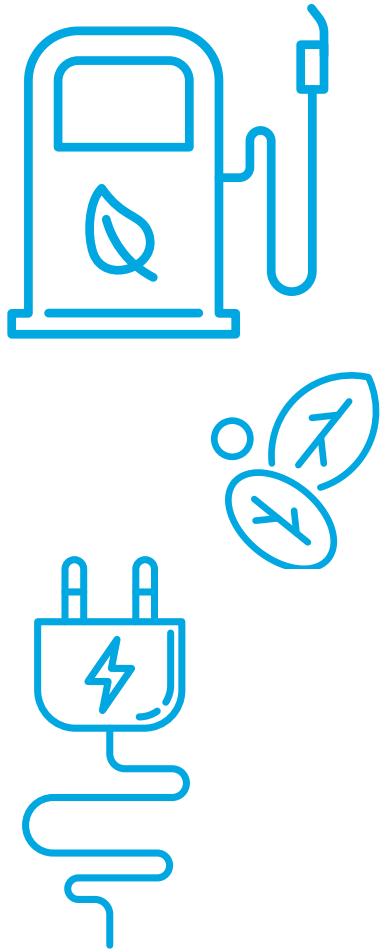
What is a Clean Fuels Policy?

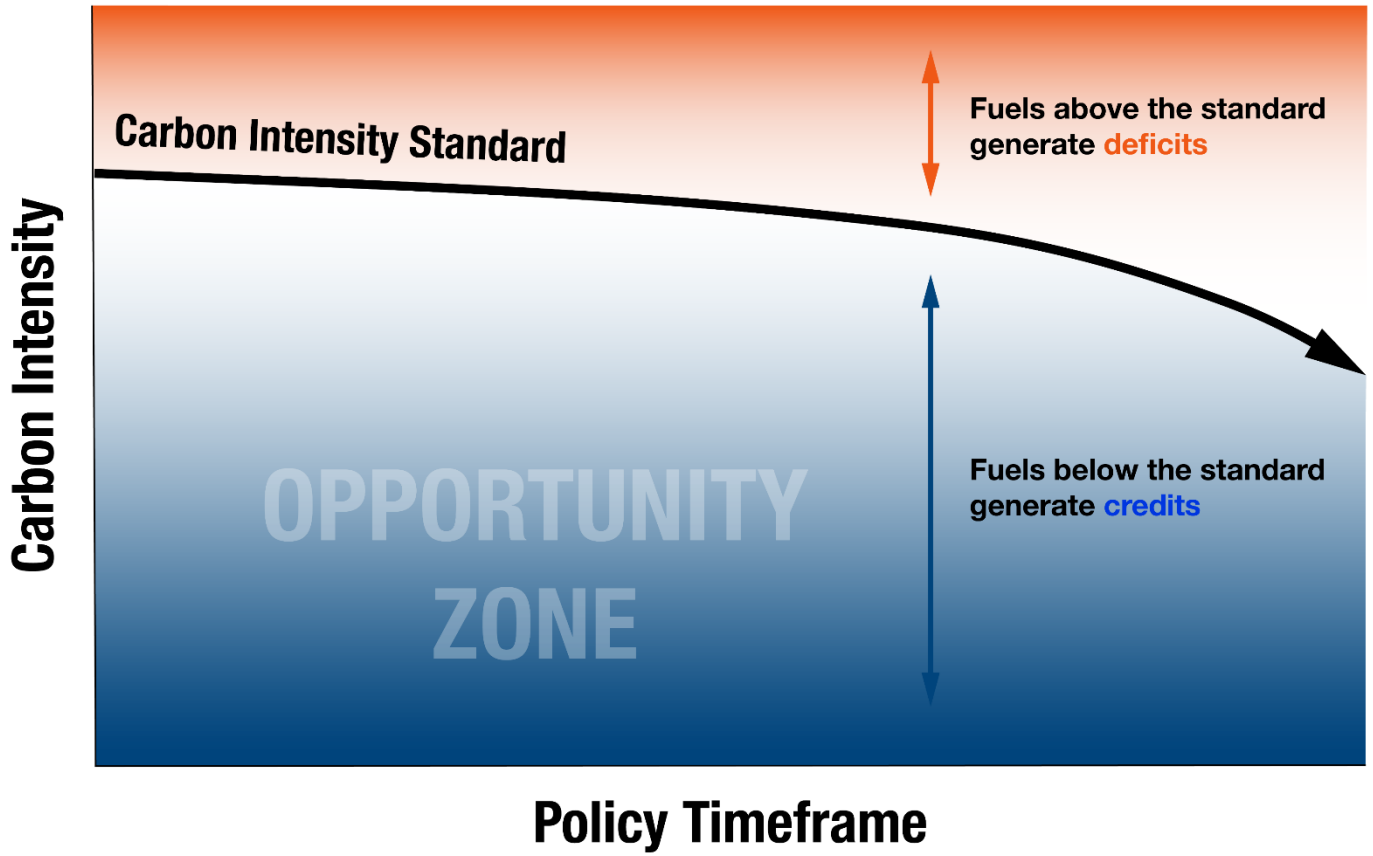
- **Market-based policy** that provides valuation to any fuel with a greenhouse gas advantage
- **Sets a standard** for reduced **carbon intensity (CI)** of fuels over time
- GHG credit market establishes **incentives for fuel producers** to lower their carbon intensity through:
  - Production process **efficiency** improvements
  - Switching to **lower carbon fuel or feedstocks**
  - **Decarbonizing** the fuel and feedstock **supply chain**
- Results in reduced use of higher carbon fuels and supports **commercial deployment** of lower carbon fuels, including ethanol



How does a Clean Fuels Policy work?

- Fuel producers that do not meet the annual baseline standard must **purchase** alternative fuel or credits

- Fuel producers that meet or exceed the standard **generate credits** proportional to the **difference in their carbon intensity and the standard**

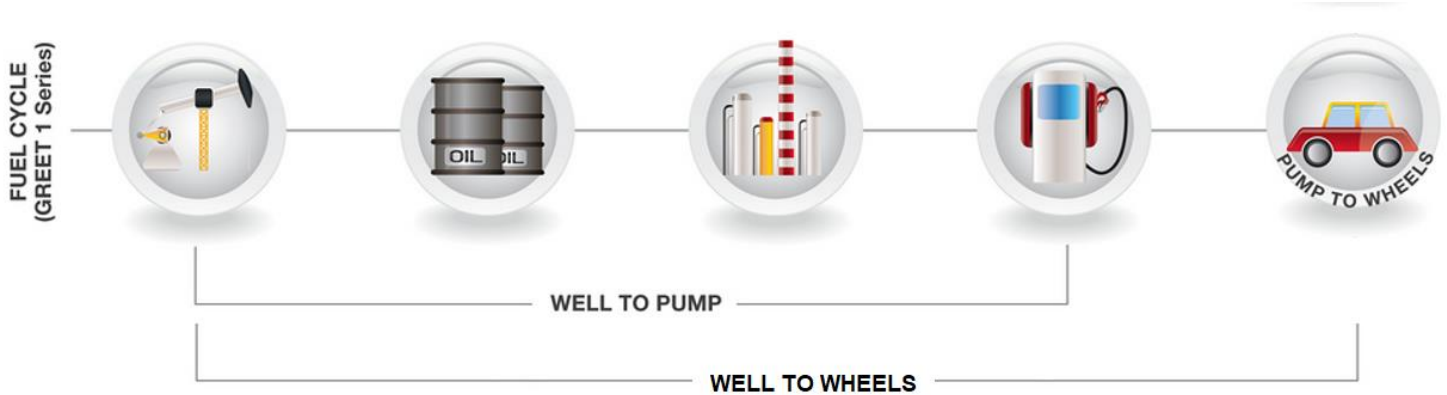


How do fuel CI calculations work?

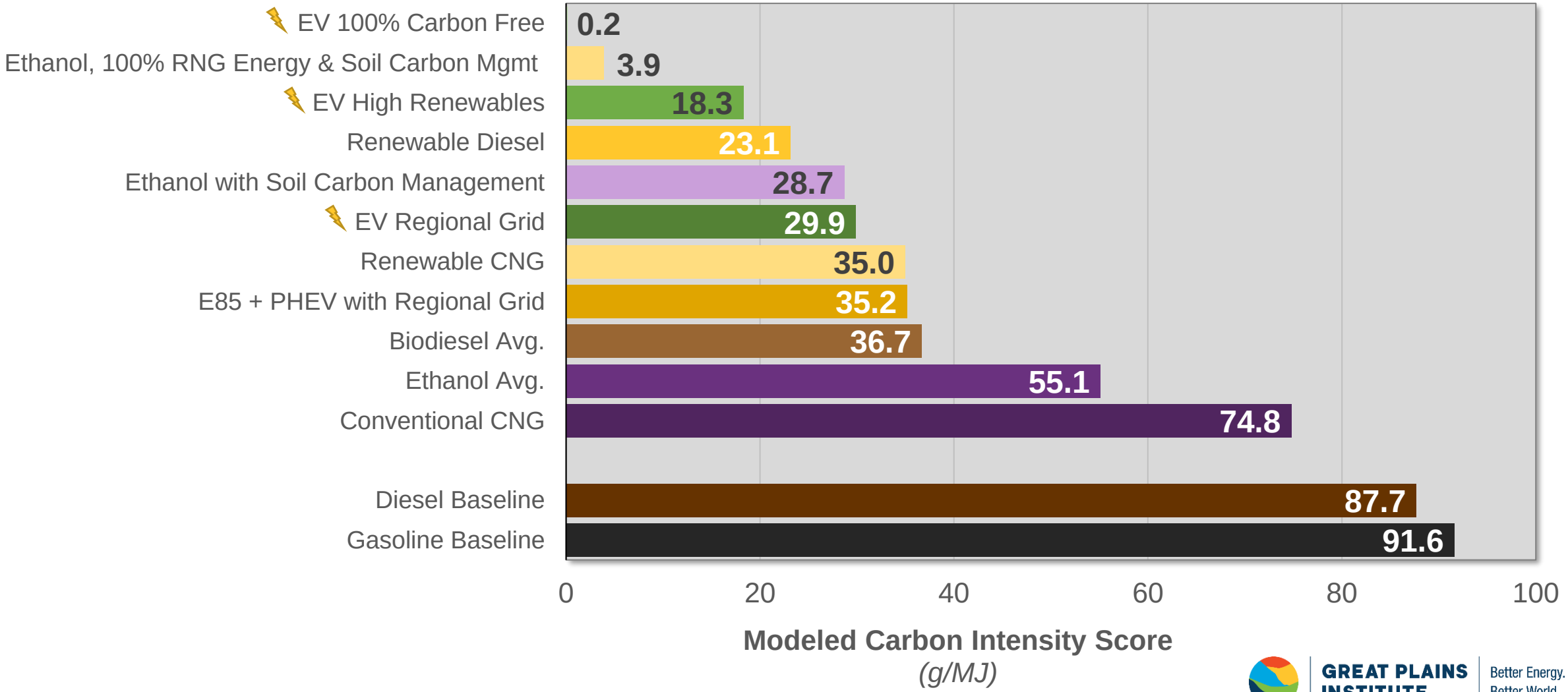
- **Greenhouse gas lifecycle assessment (or GHG LCA)** provides an estimation of all the greenhouse gas emissions associated with a fuel from feedstock production, refining, and use – or “well to wheel”
- Argonne National Laboratory’s GREET lifecycle model calculates the well-to-wheel carbon intensity of fuel production pathways

Argonne NATIONAL LABORATORY

GREET LIFE-CYCLE MODEL



Example Gasoline-Alternative Fuel Pathway Carbon Intensity Scores under a Clean Fuels Policy



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Midwestern Clean Fuels Policy Initiative

- Launched in May 2018
- Broad coalition working to create economic benefits for the Midwest through policy, research, and education on the production and use of cleaner fuels.
- Exploring clean fuels policy as a market-driven approach to achieving economic, energy security, climate, environmental, and public health goals.

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Midwestern Clean Fuels Policy Initiative Members

- Alternative Fuels Council
- American Coalition for Ethanol
- Center for Energy and Environment
- ChargePoint
- Christianson PLLP
- Coalition for Renewable Natural Gas
- Conservation Districts of Iowa
- Conservation Minnesota
- Environmental Law and Policy Center
- EcoEngineers
- Fresh Energy
- Governors' Biofuel Coalition
- Guardian Energy
- Highwater Ethanol, LLC
- Iowa Environmental Council
- Iowa Soybean Association
- Iowa State University Bioeconomy Institute
- Kansas Corn
- Low Carbon Fuel Coalition
- Minnesota Bio-Fuels Association
- National Biodiesel Board
- National Corn Growers Association
- Partnership on Waste & Energy (Hennepin, Ramsey & Washington Counties)
- Renewable Fuels Association
- Renewable Products Marketing Group
- South Dakota Corn
- Sustainable Farming Corporation
- Union of Concerned Scientists
- Urban Air Initiative
- Xcel Energy
- ZEF Energy

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MIDWESTERN VISION

- Meet and exceed existing goals and policies
- Support a portfolio of clean fuels, expand the clean fuels market
  - Technology neutral
- Broad rural and urban economic development
- Support farmer-led efforts to adopt “climate-smart” agricultural practices that improve biofuel GHG footprint
  - Opportunity for farmers to benefit from credit revenue
- Contribute to electric sector decarbonization
- Improve air quality and public health

A MIDWESTERN FRAMEWORK FOR ELECTRIC VEHICLE CREDIT GENERATION IN A CLEAN FUELS POLICY

Winter 2021

A Midwestern Framework for Electric Vehicle Credit Generation in a Clean Fuels Policy

This Midwestern framework for electric vehicle (EV) credit generation is a resource for states exploring clean fuels policy implementation. The framework provides guiding principles and policy design recommendations. It was developed by the Electric Vehicle Credit Generation Committee of the Midwestern Clean Fuels Policy Initiative, which the Great Plains Institute facilitates.

Supporting Climate-Smart Farming Practices through Midwestern Clean Fuels Policies

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Minnesota

- Future Fuels Act introduced 2021
  - HF 2083/SF 2027
  - Passed in the House in 2021
- Legislation highlights:
  - CI reduction goal: 20% reduction below 2018 levels by 2035
  - Fuel neutral
  - Focus on broad rural and urban development
  - Supports transportation electrification
  - Aim to support farmer-led decarbonization efforts

Minnesota

- Governor Walz directed the MN Dept. of Agriculture and the MN Dept. of Transportation to engage with stakeholders
    - •Identify shared goals to inform a clean fuel standard in MN
- Stakeholder meetings happened fall 2021 with various stakeholder groups
- White paper released March 2022 summarizing stakeholder feedback
- Next steps:
    - Propose convening a Midwest Clean Fuels Summit later in the year
    - Explore additional research on costs and benefits of a CFS in MN

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MN FUTURE FUELS ACT SUPPORT

Alliance for Automotive Innovation
American Coalition for Ethanol
Amp Americas
Audi of America
Biomass Solution
Center for Energy and Environment
ChargePoint
Christianson, PLLP
Conservation Minnesota
Farmers Business Network
Fresh Energy
General Motors
Low Carbon Fuels Coalition
Minnesota Bio-Fuels Association
Partnership on Waste and Energy
Plug In America
Rivian
Sustainable Farming Corporation
Tesla
The Coalition for Renewable Natural Gas
The Nature Conservancy
The Renewable Fuels Association
Union of Concerned Scientists
Universal Renewable Products, LLC
Xcel Energy

Biofuel Blending	Current (2018) Conditions	10% Carbon Intensity Reduction	15% Carbon Intensity Reduction	20% Carbon Intensity Reduction
Ethanol	Average blend rate: 12.5% in MN and 11.5% in IA	Increased E15 and E30 blending; increased E85 consumption	**Increased E15 and E30 blending; increased E85 consumption 5-7% carbon intensity (CI) decrease by 2030**	Increased E15 and E30 blending; increased E85 consumption 15-17% CI decreases by 2030
Biodiesel	Average blend rate: 11.3% in MN and 8.8% in Iowa	15% biodiesel blend No change in CI	**15-20% biodiesel blend 18% decrease in CI by 2030**	20-25% biodiesel blend 18% decrease in CI by 2030
Renewable diesel	0% renewable diesel blend in Midwestern states	5% blend by 2030	**10% blend by 2030**	10% blend by 2030
Renewable natural gas (RNG)	De minimus use of RNG in Minnesota and Iowa.	95% RNG by 2030 Limited to Landfill gas	**Landfill gas with transition to low CI RNG**	Landfill gas with transition to low CI RNG

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	Current (2018) Conditions	10% Carbon Intensity Reduction	15% Carbon Intensity Reduction	20% Carbon Intensity Reduction
Vehicle Replacement				
EVs, Light Duty	<1% of fleet in MN and IA.	9% EV sales by 2025 Expected increase in low-carbon generation by 2030	**16% EV sales by 2025** **Expected increase in low carbon generation by 2030**	24% EV sales by 2025 Increased use of low carbon generation by 2030 by 2030
EVs, medium duty (MD)/heavy duty (HD)	<1% of fleet in MN and IA.	Baseline adoption (<1% of fleet by 2030)	**Modest adoption in MD/HD sectors representing 2.5% of fleet by 2030**	Accelerated adoption in MD/HD sectors representing 5% of fleet by 2030
Natural Gas Vehicles (NGVs), Heavy Duty	De minimus use of RNG in Minnesota and Iowa.	Expected growth of (NGVs)	**Expected growth of NGVs**	Expected growth of NGVs

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Average Annual Impact across Economic Metrics

Type	Average Annual Impact (2021 – 2030) *in $USD 2019*
Output impacts	$1.033 billion
Value added	$197 million
Employment	1,498 annual FTE *(14,976 total)*
Employment income	$95 million
State and local tax impact	$13 million
Federal tax impact	$33 million

- **Output impacts** describe the total value of product sales and/or services generated across the local economy.
- **Value added** estimates average annual contributions to gross domestic product.
- **Employment** estimates the number of annual full-time equivalencies (also measured in job years) that the policy would support.
- **Employment income** models the average annual sum of the income generated by the jobs supported through the policy.
- **Tax impact** (modeled at local, state, and federal levels) include all taxes on employee
- compensation, proprietor income, production and imports, households, & corporations.

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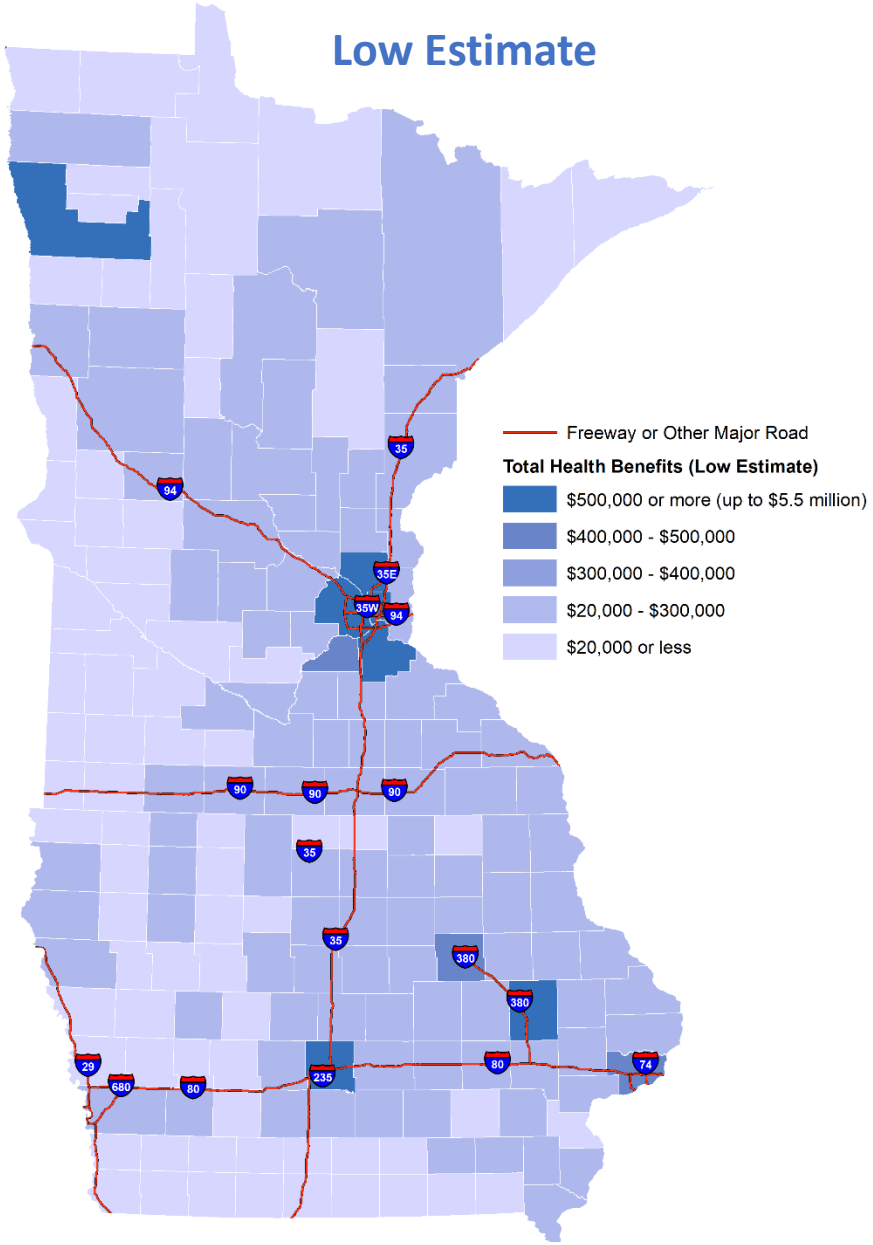
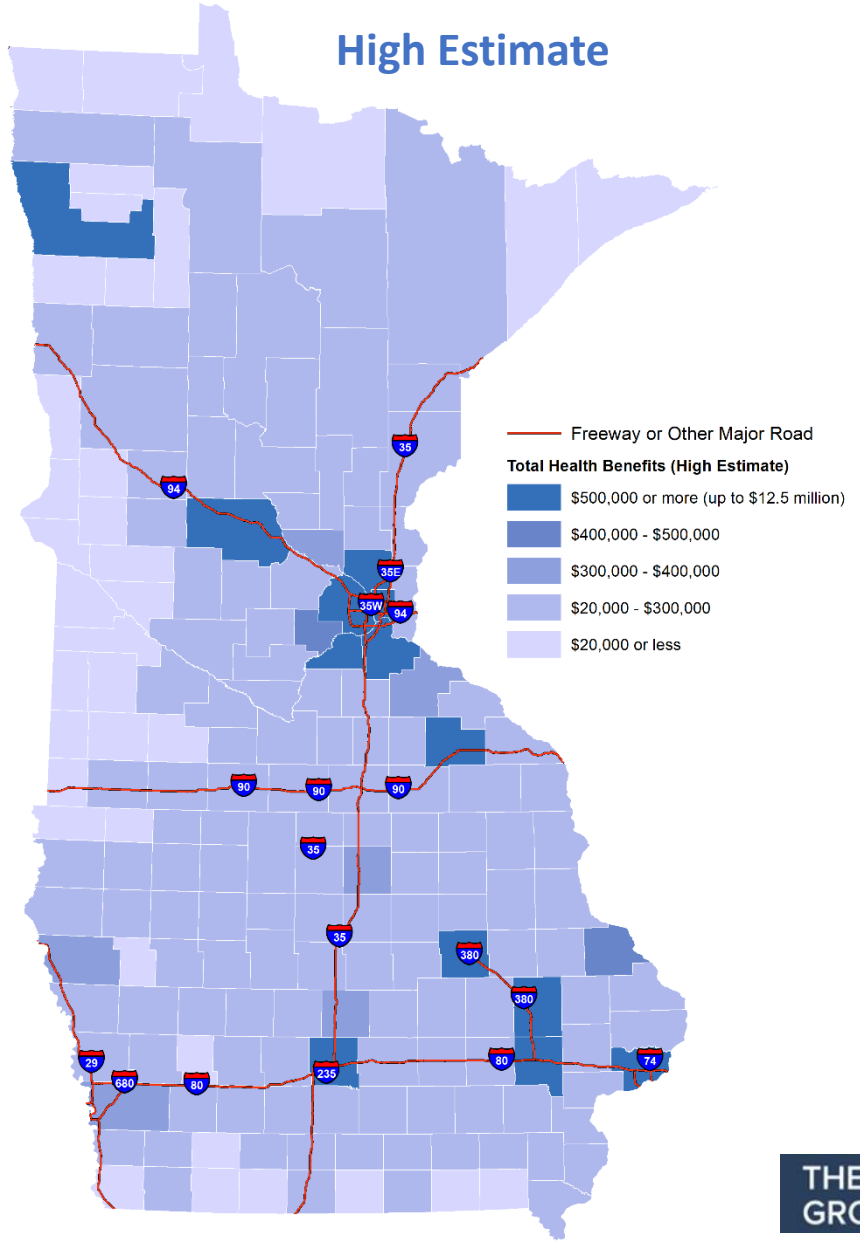
Health Benefits from Reduced NOx and SOx Emissions

Low Estimate



High Estimate



Statewide Total Annual Health Benefit Estimates (Sum of All Counties)

State	Low Estimate
Minnesota	$15,691,924
Iowa	$7,544,220

State	High Estimate
Minnesota	$35,292,517
Iowa	$16,989,631

Preliminary analysis – Do not cite or quote

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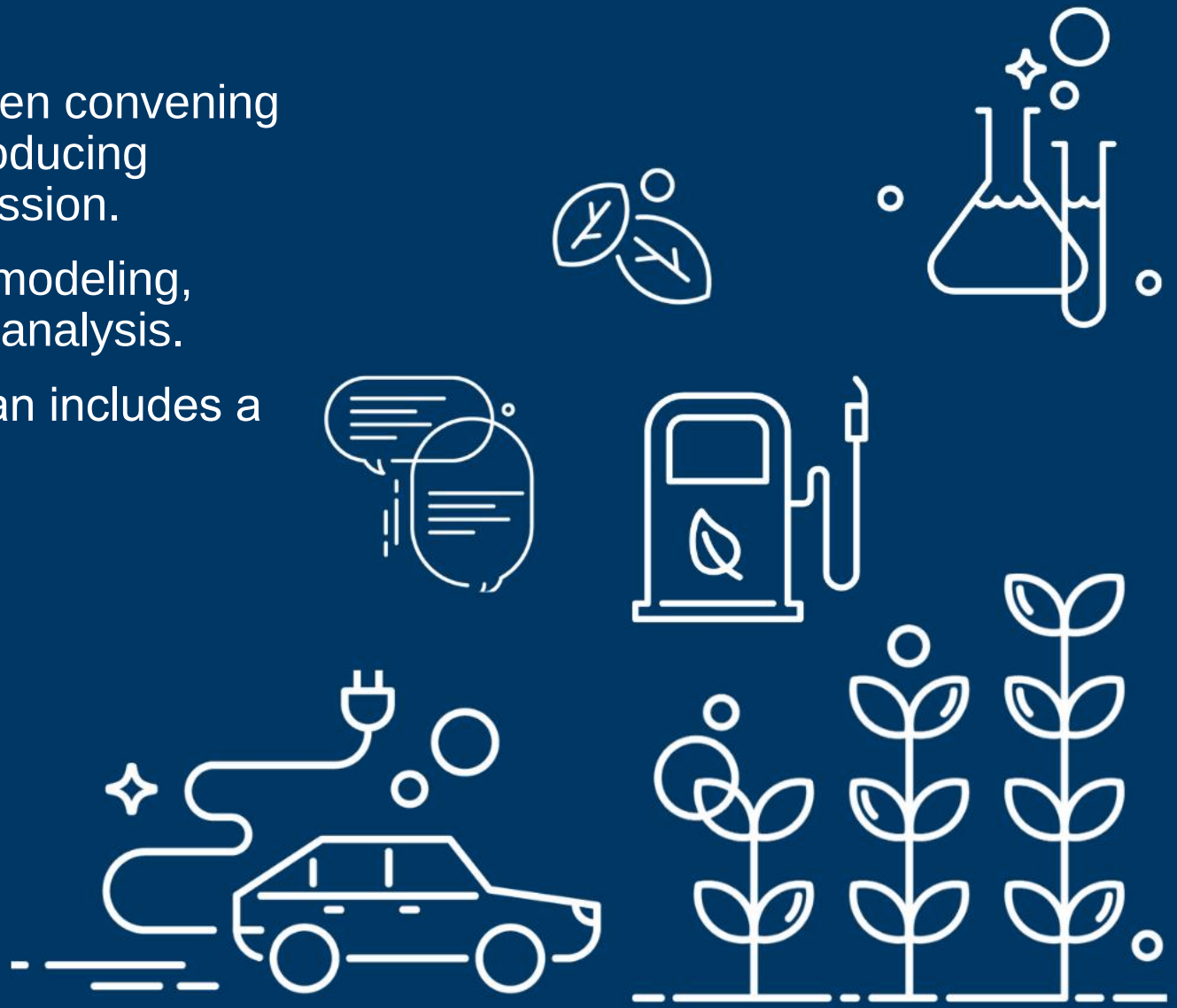
Michigan

- A CFS policy steering committee has been convening for a few months and is considering introducing legislation during the 2023 legislative session.
- GPI is working on compliance scenario modeling, economic impact, and air quality impact analysis.
- Governor Whitmer's Healthy Climate Plan includes a recommendation for a CFS.



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Other Midwest States

- In Nebraska and Ohio, diverse groups of stakeholders are considering clean fuels policy legislation
- GPI is working on compliance scenario modeling, economic impact modeling, and air quality modeling for both states.
- No legislation has been introduced.

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CAROLYN BERNINGER,

PUBLIC POLICY MANAGER

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Clean Fuels Alliance America

Clean Fuels
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Low Carbon Fuel Programs: Status and Impacts

Floyd Vergara, Esq., P.E.
Director of State Governmental Affairs

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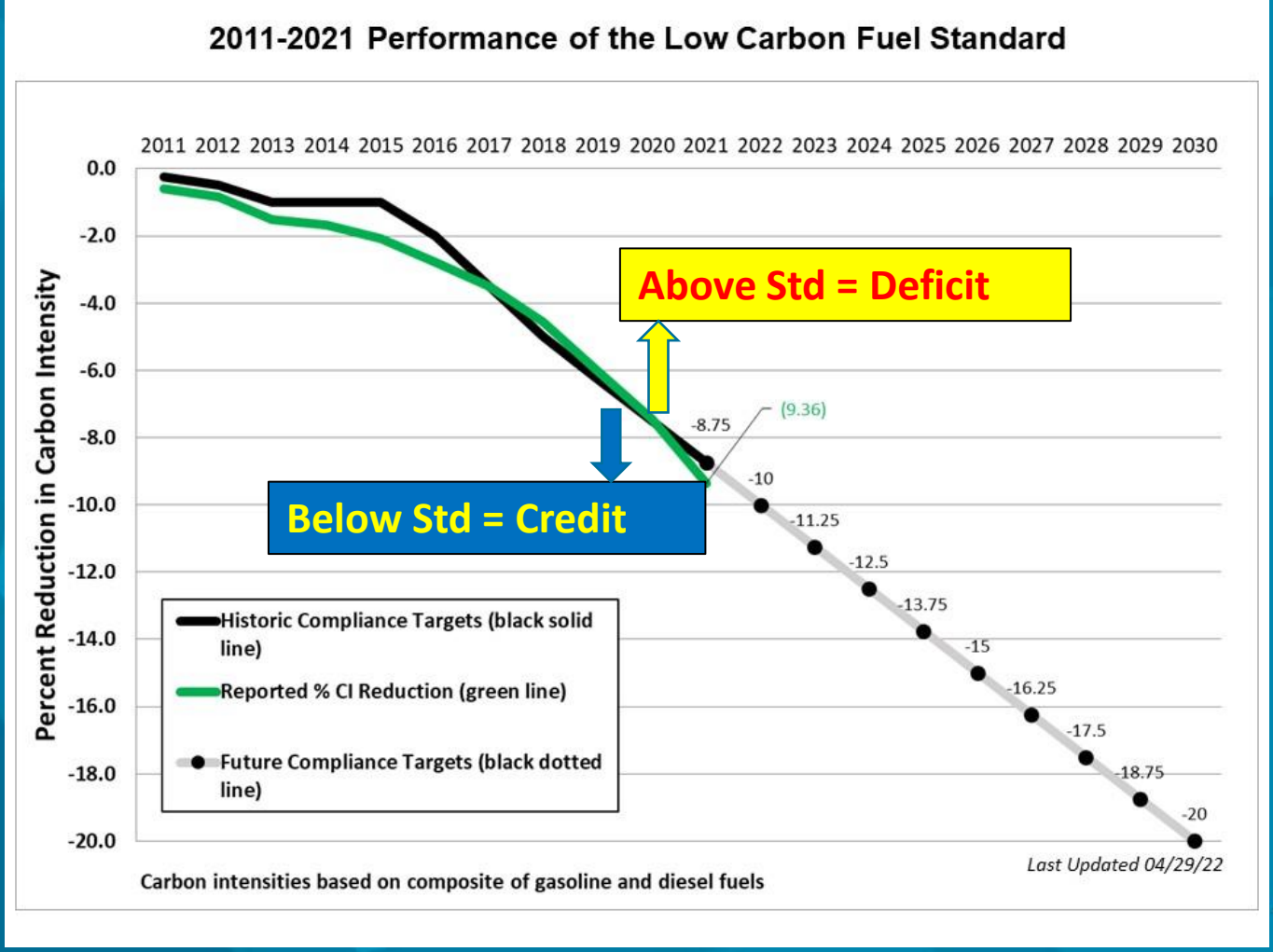
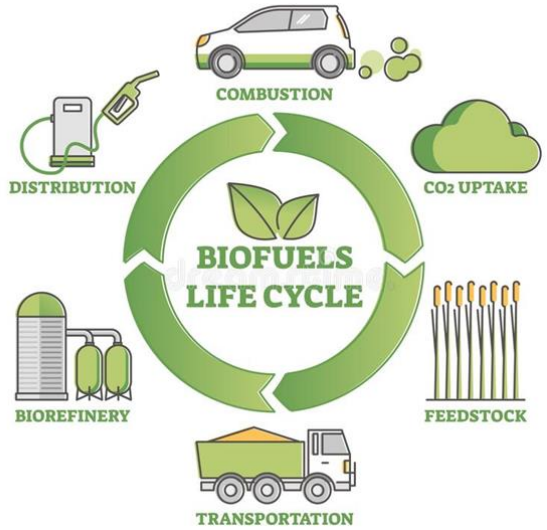
Status Of Low Carbon Fuel Programs On West Coast

CA's Highly Successful Low Carbon Fuel Standard



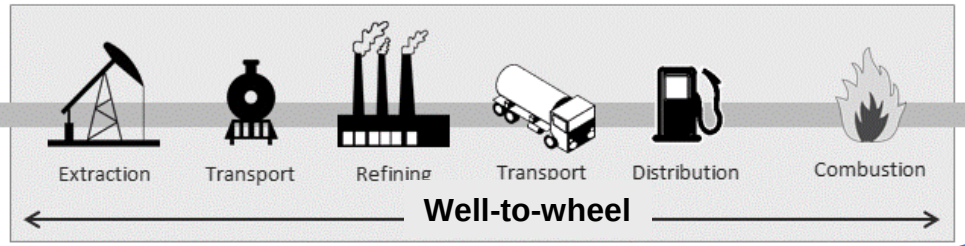
- In effect since 2011
- Virtually all transp. Fuels
- Full lifecycle carbon intensity targets
- Currently overperforming
  - 10% CI reduction by 2022
  - 20% CI reduction by 2030
  - Pre-/post-2030 under consideration
- 110MMT GHGs reduced since 2011 (~24M cars removed)

Biofuels Reduce GHGs By Recycling CO_2



Biofuels

Petroleum Fuels



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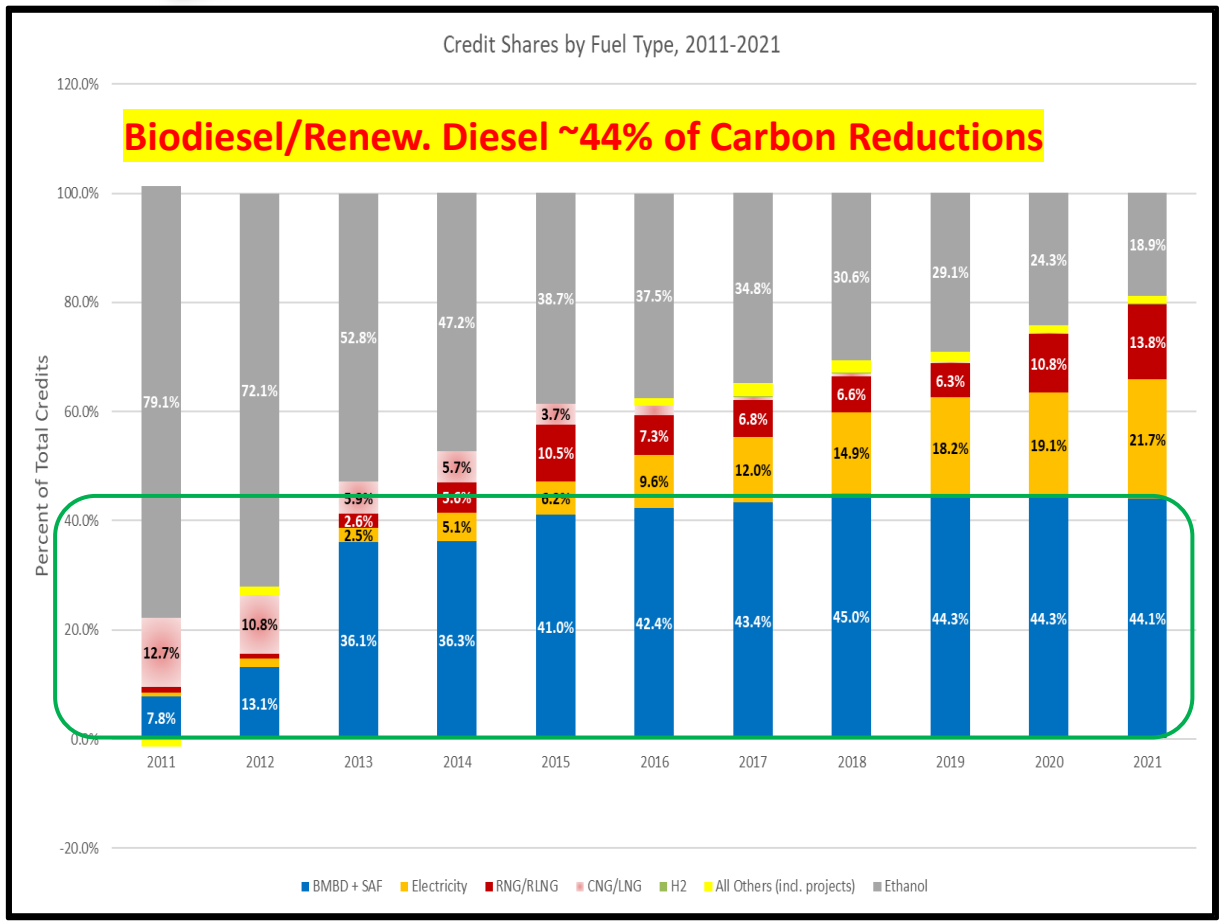
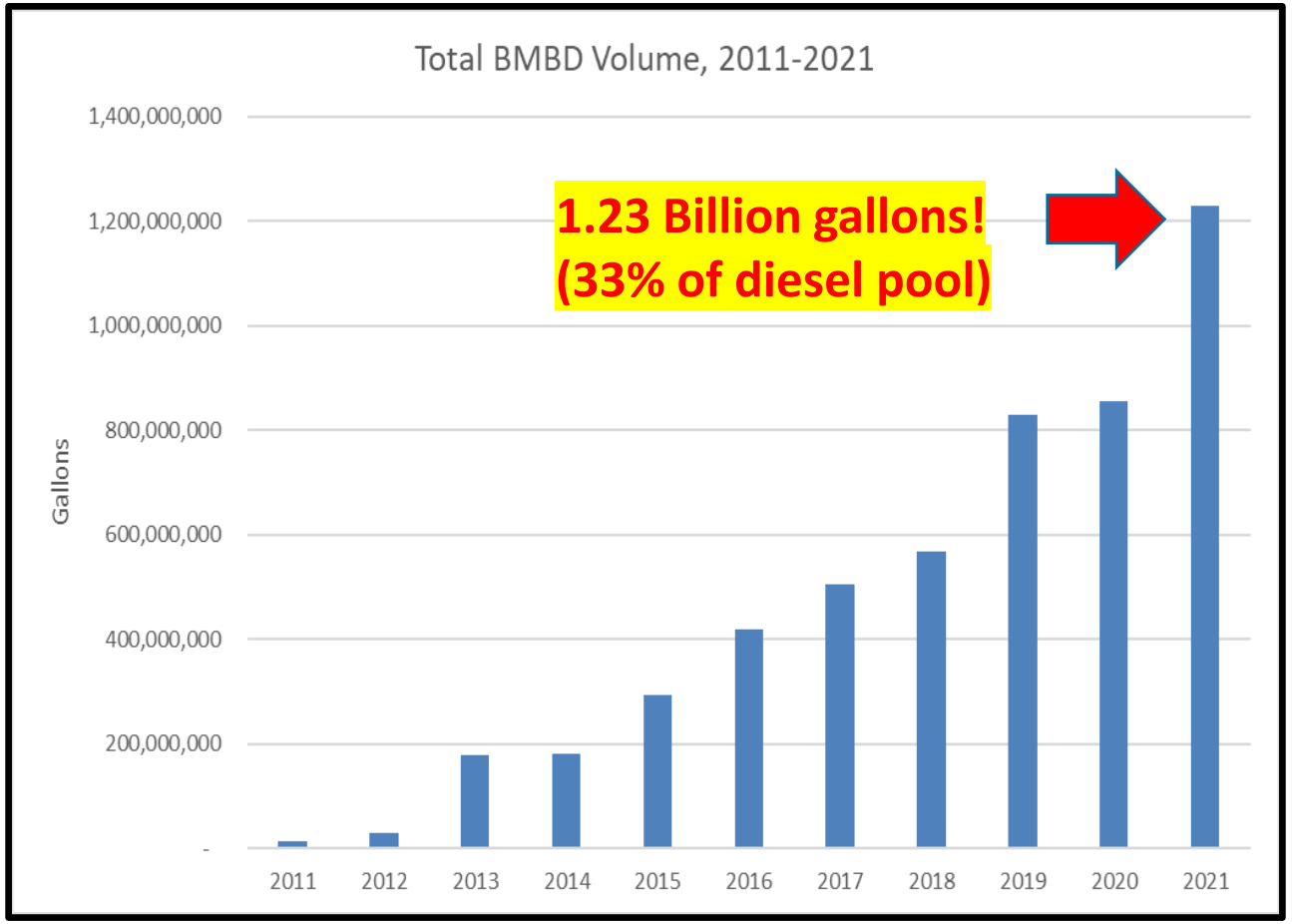
Drop-in, Low Carbon Diesel Replacements Play Key Role In CA

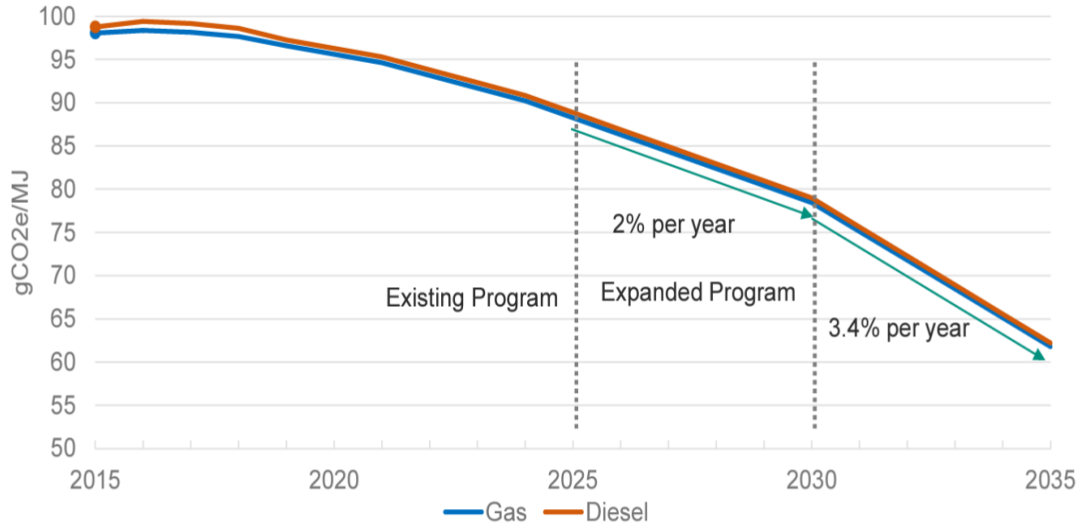




Source: CA LCFS Dashboard

Oregon Recently Expanded Clean Fuels Program

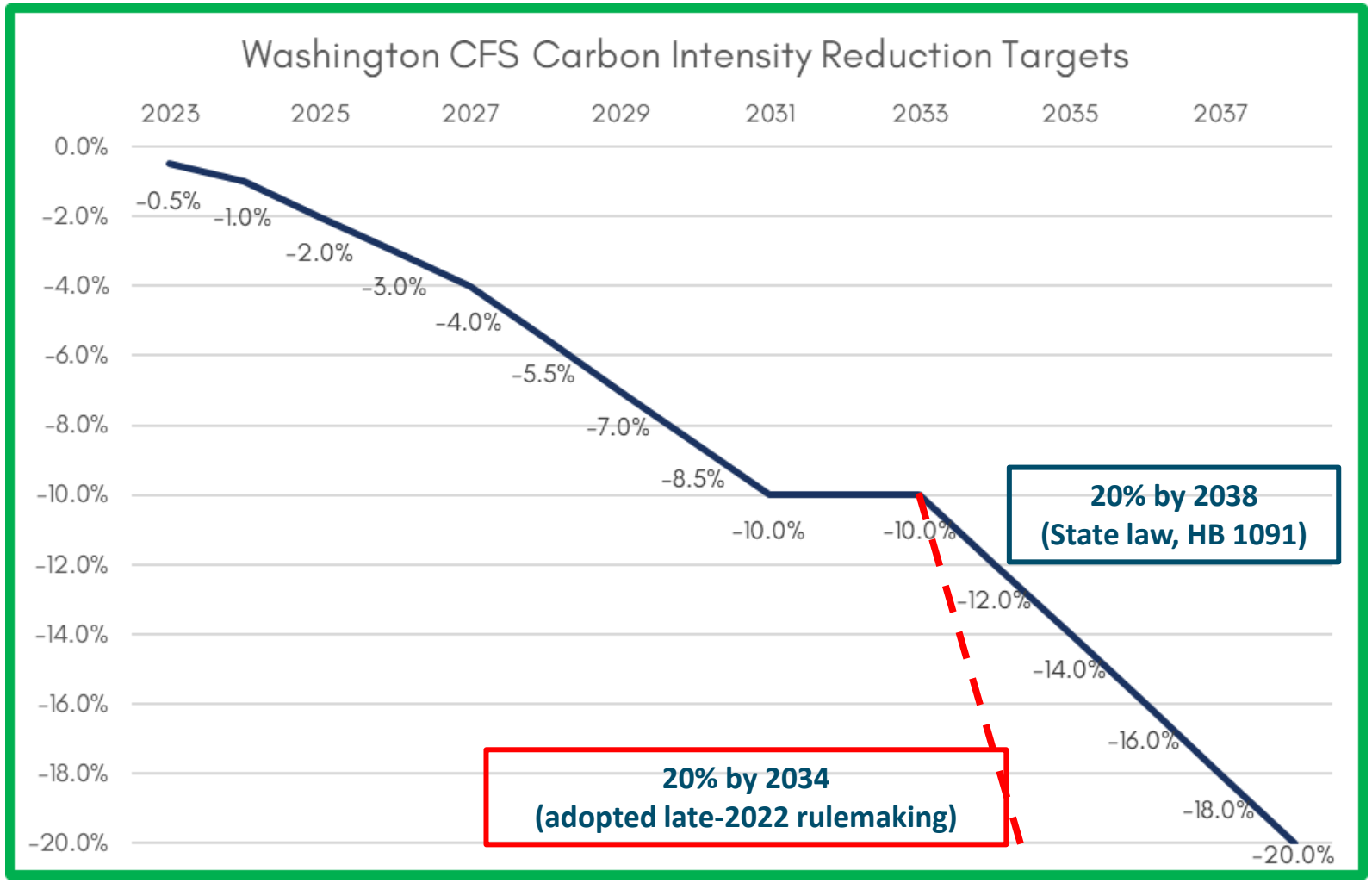
Carbon Intensity Targets



Existing Program	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
% Reduction	0.25%	0.5%	1.0%	1.5%	2.5%	3.5%	5.0%	6.5%	8.0%	10.0%
% Change YoY	0.25%	0.25%	0.5%	0.5%	1.0%	1.0%	1.5%	1.5%	1.5%	2.0%
Proposal for Expanded Program	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
% Reduction	12.0	14.0%	16.0%	18.0%	20.0%	23.4%	26.8%	30.2%	33.6%	37.0%
% Change YoY	2.0%	2.0%	2.0%	2.0%	2.0%	3.4%	3.4%	3.4%	3.4%	3.4%

- CI Reduction Targets
  - 10% by 2025 (existing)
  - **20% by 2030 (adopted)**
  - **37% by 2035 (adopted)**
- 760 Mgal/yr diesel market
- Modeled 15%-77% blend rates by 2035 (at 25% CI target)
  - (114 Mgal – **585 Mgal**)
- BMBD single biggest source of GHG reductions in CFP
  - 136 Mgal BD/RD (2022, forecast), 17% blend
  - 48% of credits in 2020, 54% in 2021 (forecast)
- "continued demand for low-carbon liquid fuels for decades"

WA Clean Fuel Standard (CFS)



- 10% CI reduction by 2031, 20% by 2038 (HB 1091)
  - 0.5% annually 2023-2024
  - 1.0% annually 2025-2027
  - 1.5% annually 2028-2031
  - 2.0% annually 2034-2038
- 950 Mgal diesel market
  - 140 Mgal as B20
- Adopted late-Nov 2022 **(10% by 2031, 20% by 2034)**

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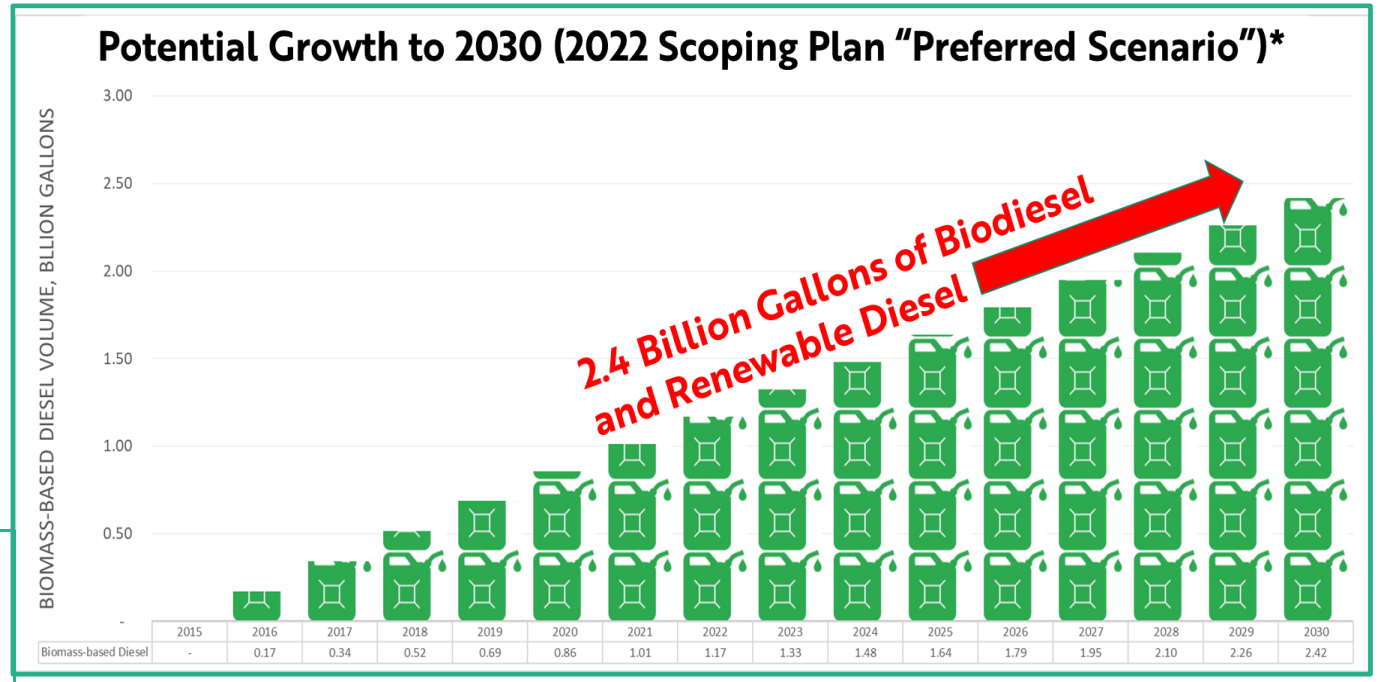
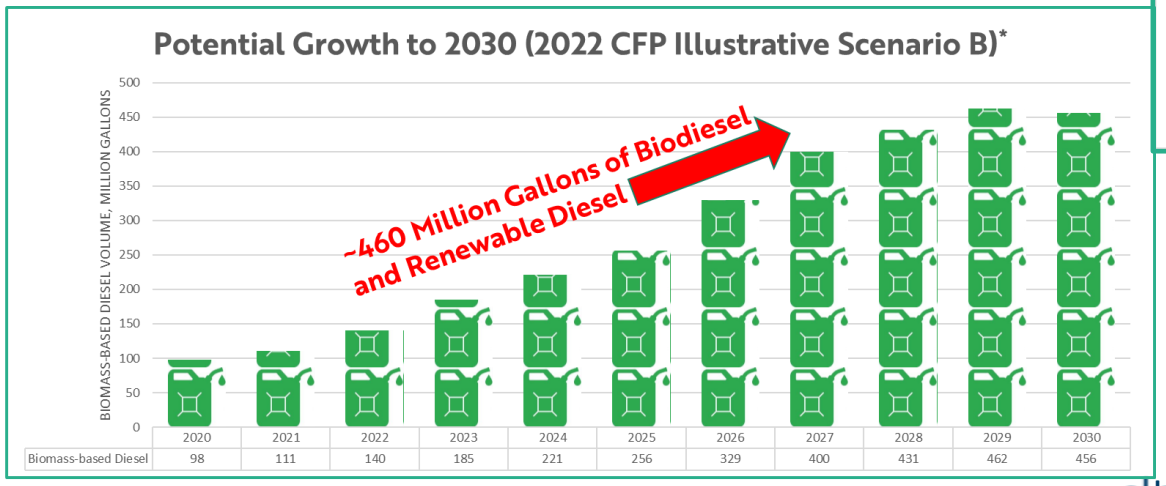
Both CA And OR Doubling Down On Low Carbon Fuels



Source: CARB Scoping Plan, 2022



Source: 2022 OR Clean Fuels Expansion Rulemaking, ICF 2021

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Economic Benefits

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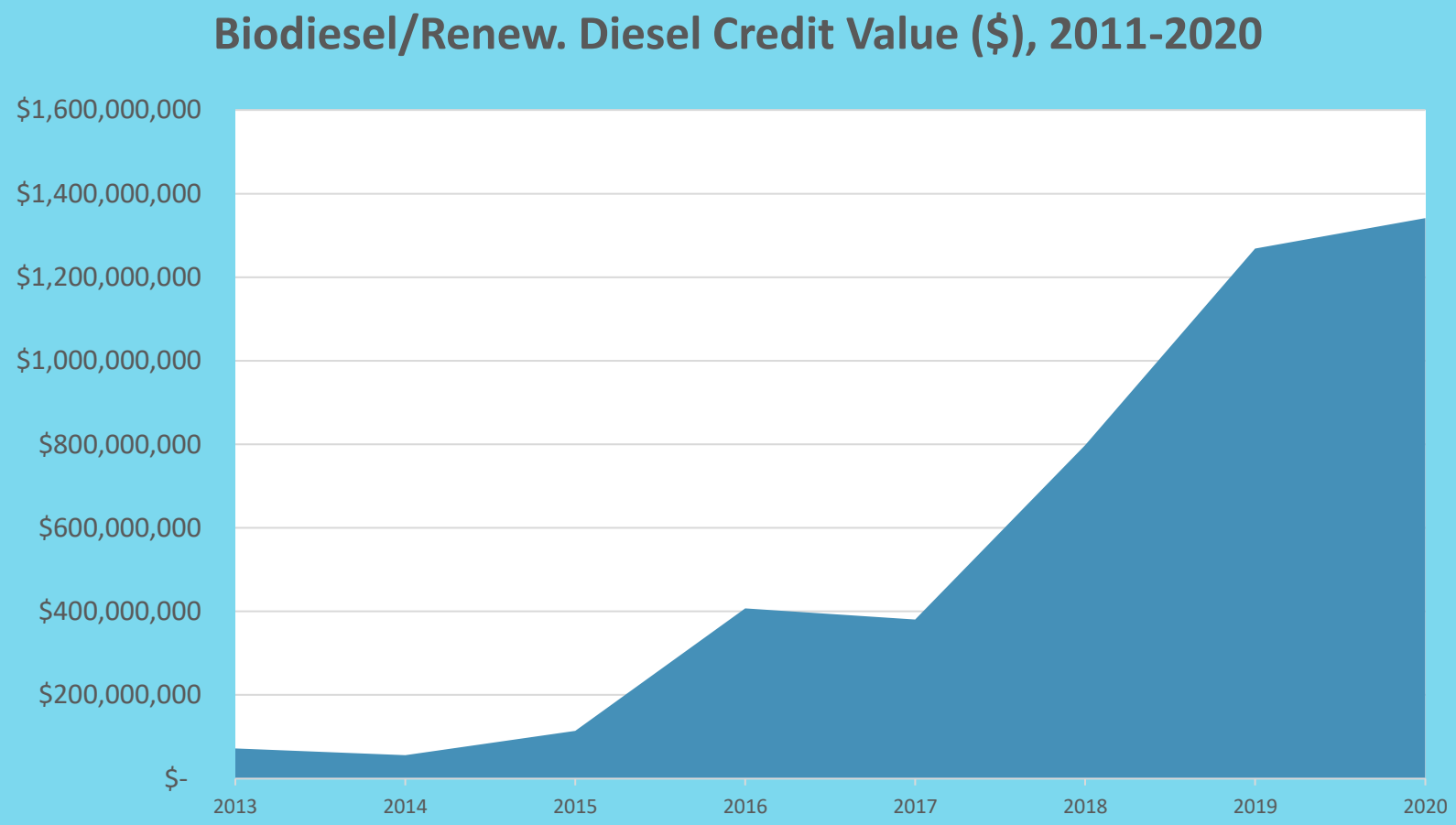
LCFS Generates Substantial Value

- Strong market signal = $Billions in investments
- For Biodiesel/RD in CA alone:
  - 6.8M credits generated in 2020 valued at **$1.34 Billion** (at $199/credit)
  - **$4.44B** credits since 2011
- ~ $1.60/gal value from credits



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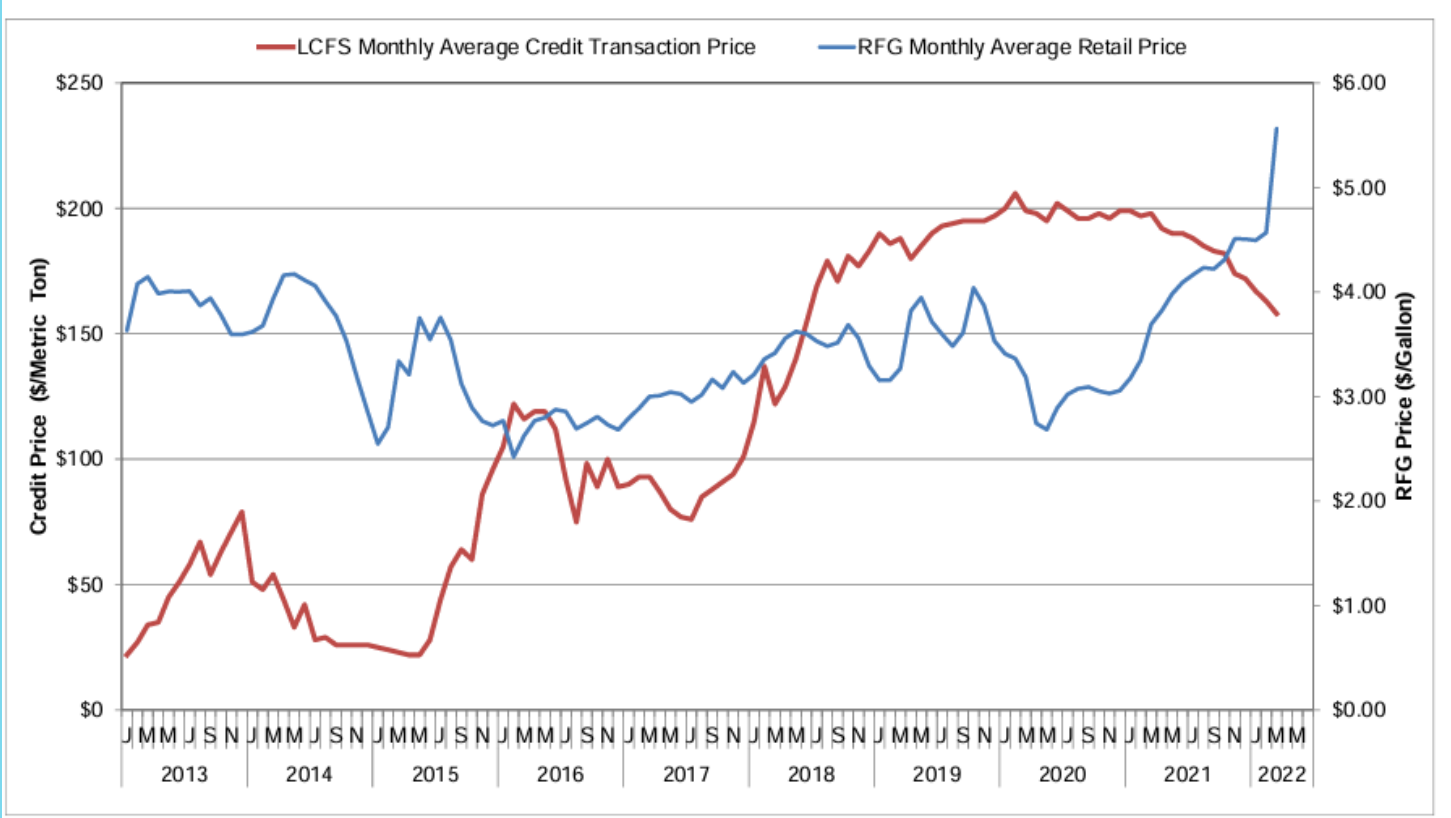
Credit Prices Not Correlated With Pump Prices



- No direct correlation between credit prices and retail pump prices
- Very strong correlation between retail pump prices and crude oil, state & fed. taxes

Source: Bates White 2022, using CARB LCFS Credit Prices and EIA Retail Pump Price Data

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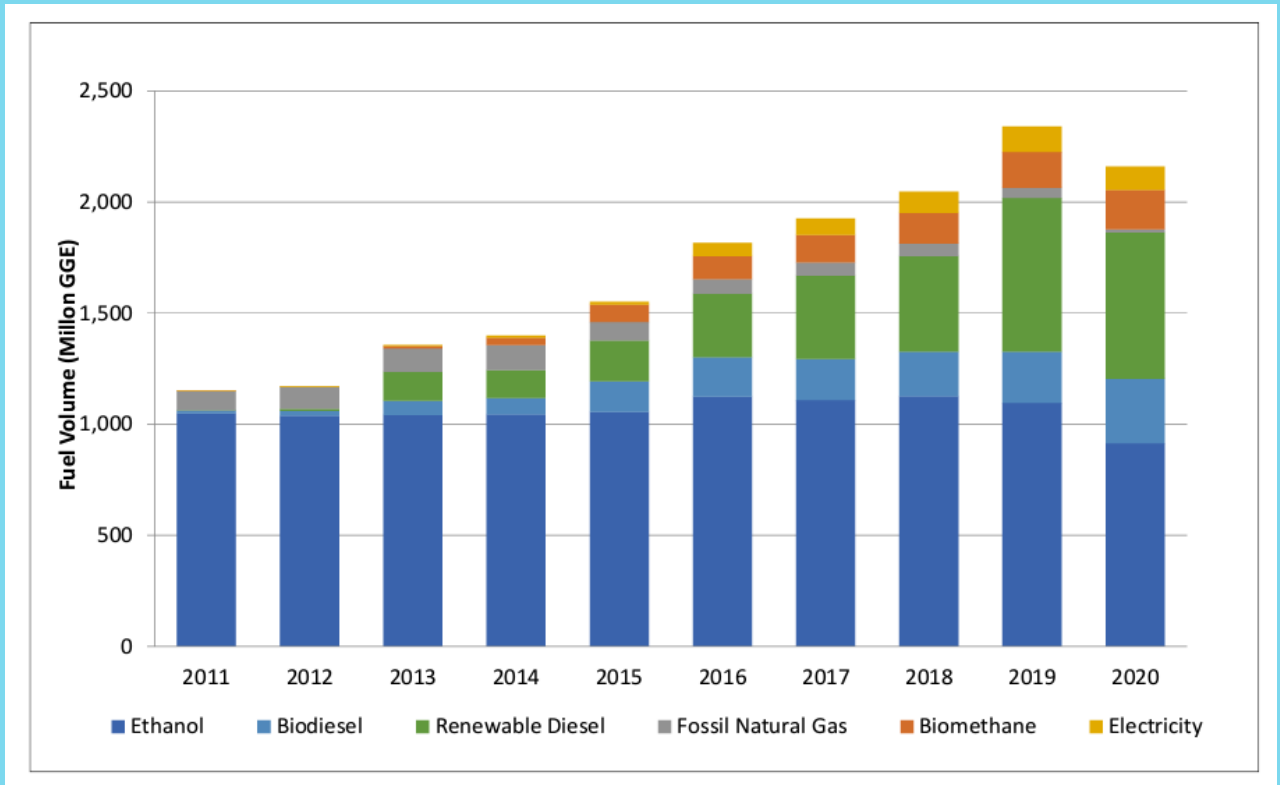
GREATER FUEL DIVERSIFICATION, CONSUMER CHOICES



Source: Bates White, April 2022, from CARB LCFS Dashboard

- At start of program, ethanol was predominant alt. fuel
- Since 2011, diversity of fuels has increased
- Choices available now electricity, renewable natural gas, biodiesel, renewable diesel, other emerging fuels

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Environmental and Public Health Benefits

ENVIRONMENTAL BENEFITS: GHGs & MORE

	B100	RD100	B20 RD80	B50 RD50
GHG	Up to 79% less carbon emissions.	Up to 79% less carbon emissions.	Up to 79% less carbon emissions.	Up to 79% less carbon emissions.
PM	80% particulate matter reduction.	5-28% particulate matter reduction.	29% particulate matter reduction.	56% particulate matter reduction.
BTX	75% fewer aromatic compounds.	30% fewer aromatic compounds.	39% fewer aromatic compounds.	53% fewer aromatic compounds.
CO	42% less carbon monoxide.	18% less carbon monoxide.	23% less carbon monoxide.	30% less carbon monoxide.
NO_x	NOx neutral.	11.5% NOx reduction.	9% NOx reduction.	6% NOx reduction.

- Virtually all alternative fuels reduce GHGs and air pollution
- LCFS increases fuel diversity, accelerates electrification & low carbon diesel replacements
- 110 MMT GHGs reduced in CA
- Biodiesel and Renew. Diesel:
  - 74% GHG reductions on average
  - Up to 80% PM reduction in legacy vehicles

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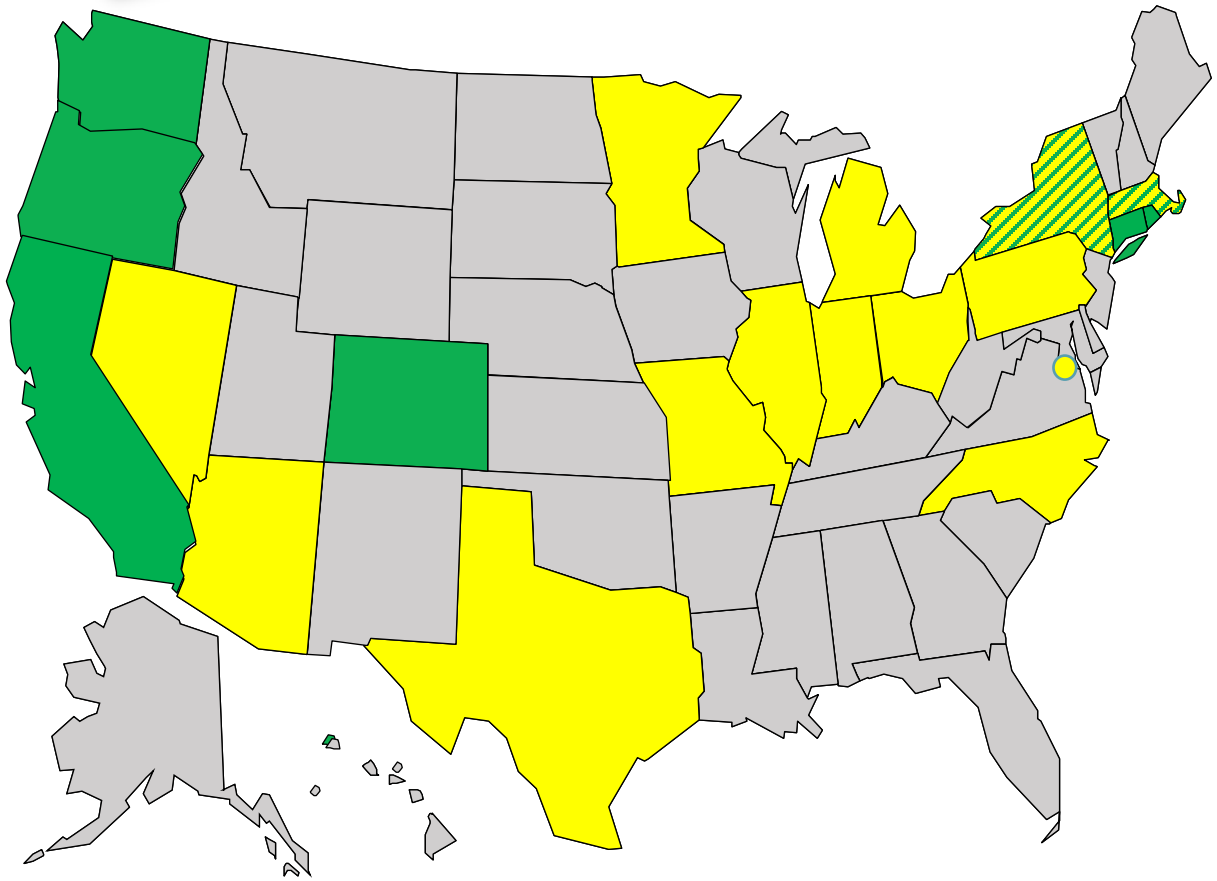
TRINITY STUDY SITES (RANGE OF SOURCES, AREAS)



Phase 1 Phase 2 Phase 1 & 2 - cleanfuels.org -

Geographic Scope

- 28 sites, 21 states
- Both coasts, Midwest, Southwest, D.C.

Source Types

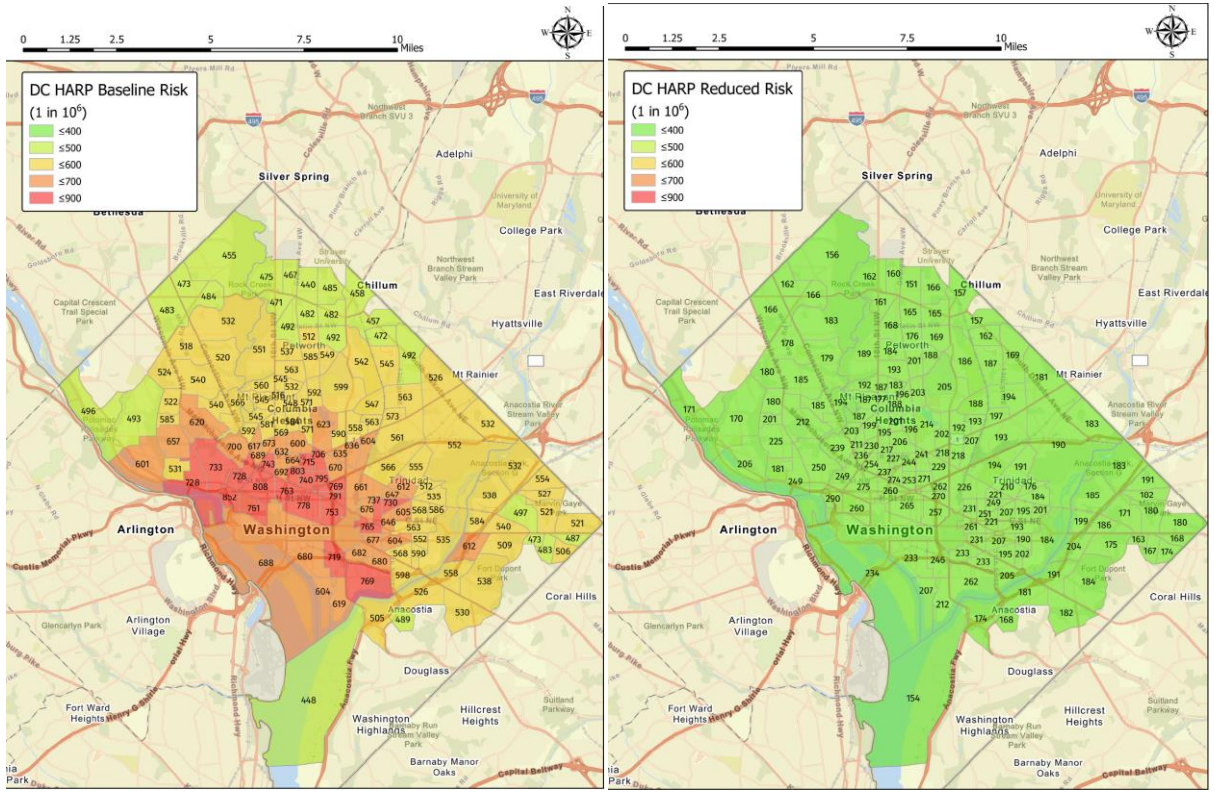
- Transport: Legacy HD trucks/engines at ports, urban, agricultural, logistics, railyards
- Heating oil: residential, commercial

Key Considerations

- ALA State of the Air Report
- States with carbon policies or considering them

B100 SWITCH: DISTRICT OF COLUMBIA – TRANSPORT

Cancer Risk Pre/Post-Switch to B100 (Up to 193 fewer cases)



Value of Health Benefits from using Biodiesel in the District of Columbia (Per Year)		
Health Impact Endpoint	**Reduced Incidence**	**Benefit Value**
Acute Myocardial Infarction Nonfatal	100.6	$3,303,129
Asthma Symptoms Albuterol use	**12,987.1**	**$4,488**
ER visits All Cardiac Outcomes	12.3	$14,299
ER visits respiratory	28.1	$24,598
HA All Respiratory	3.1	$54,807
HA Alzheimers Disease	10.5	$133,287
HA Cardio- Cerebro- and Peripheral Vascular Disease	4.3	$68,492
HA Parkinsons Disease	1.7	$22,980
HA Respiratory-2	0.6	$0
HA Respiratory-2 HA All Respiratory	3.7	$0
Incidence Asthma	**98.8**	**$4,414,345**
Incidence Hay Fever/Rhinitis	619.3	$371,503
Incidence Lung Cancer	4.7	$59,160
Incidence Out of Hospital Cardiac Arrest	0.6	$20,552
Incidence Stroke	1.9	$63,297
Minor Restricted Activity Days	**33,036.1**	**$2,298,710**
Mortality All Cause	**32.1**	**$249,689,228**
Work Loss Days	**5,679.9**	**$1,467,432**
Total		**$262,010,307**

Source: Health Benefits Study, Clean Fuels 2022

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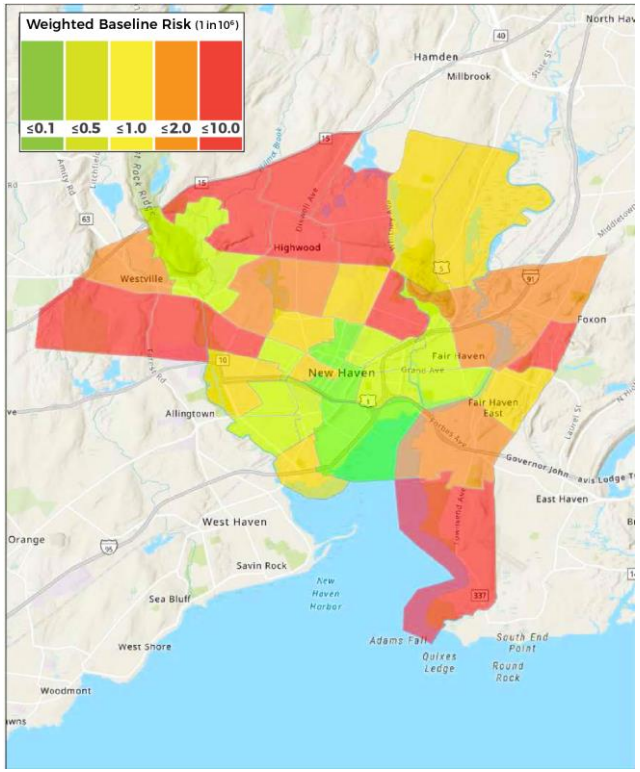
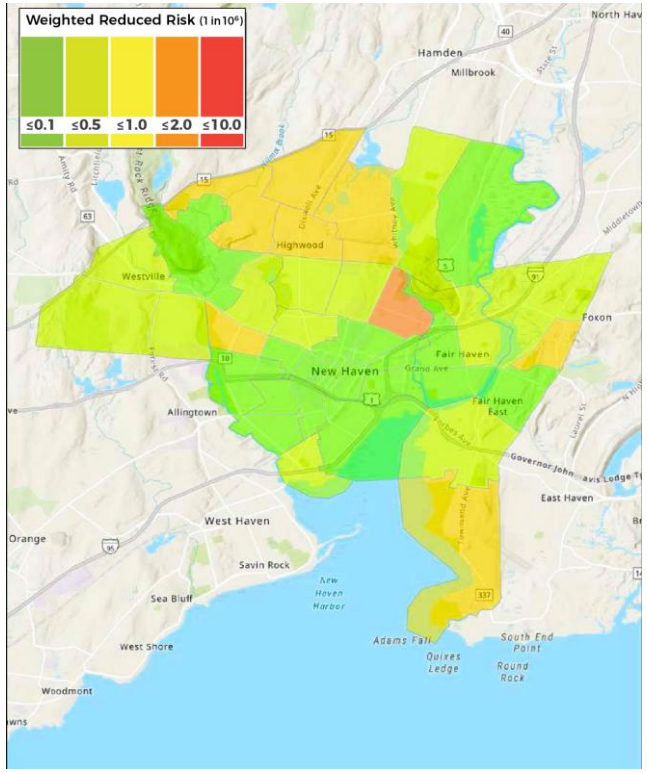
B100 SWITCH: NEW HAVEN, CT – HEATING OIL

Cancer Risk Pre/Post-Switch to B100 (Up to 85% reduction)





Valuation of Reduced Incidence Benefits		
Endpoint	Reduced Incidence	Benefit Value
Premature Mortality	2.3	$20,413,656
Asthma Exacerbation	1,073	$63,195
Minor Restricted Activity Days	1,380	$96,001
Work Loss Days	232	$46,899
Total		$20,619,751

Reduction in Health Impacts					
Baseline Cancer Risk (1 in 10^6)	Cancer Risk Reduced to (1 in 10^6)	Change in Cancer Risk (1 in 10^6)	Baseline Tot. Cancer Burden (for study location)	Tot. Cancer Burden (for study location)	Change in Cancer Burden (for study location)
7.4	1.1	6.3 (85%)	<1	<1	(85%)

Source: Health Benefits Study, Clean Fuels 2022

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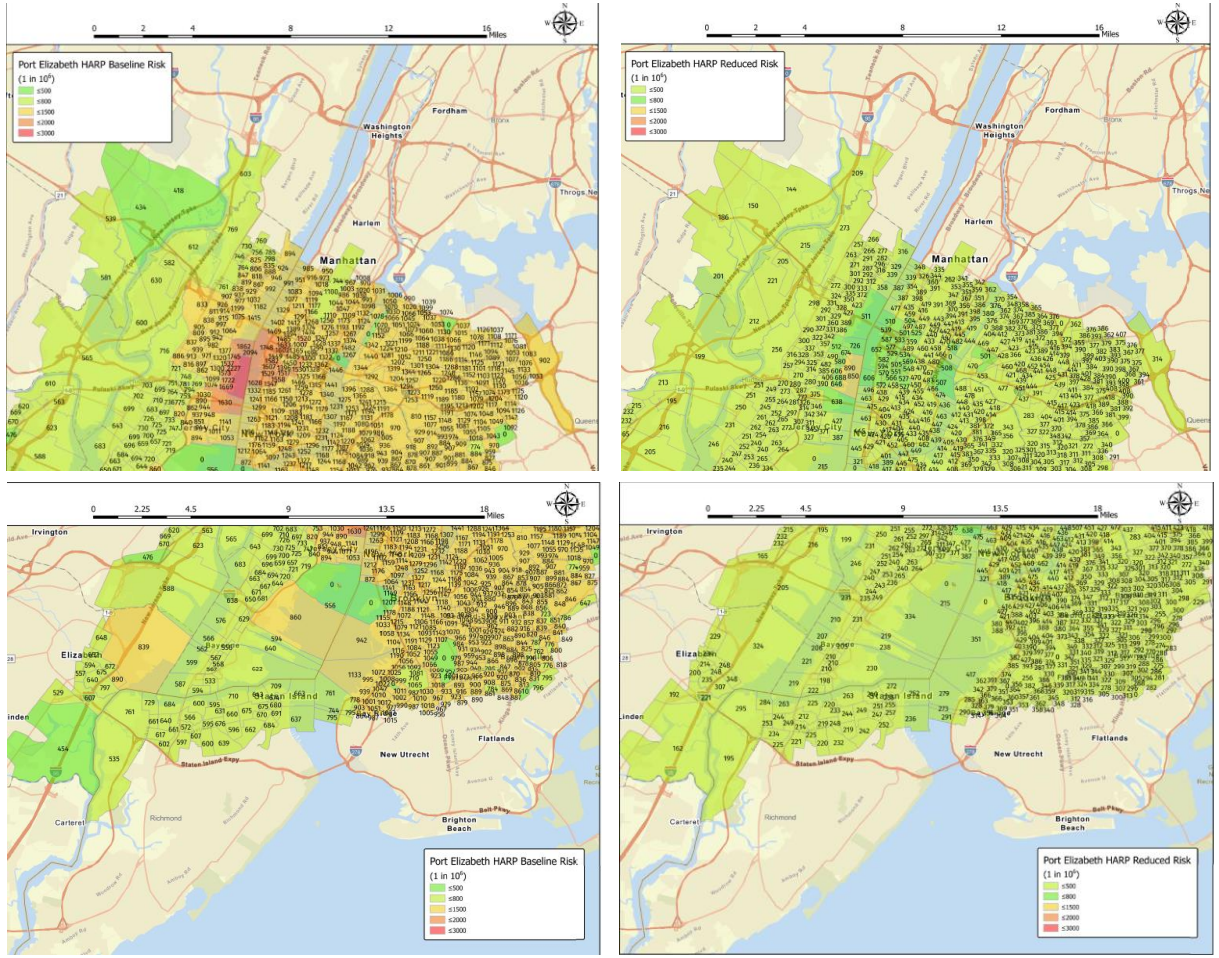
B100 SWITCH: PORT ELIZABETH (NY/NJ) – PORT

Cancer Risk Pre/Post-Switch to B100 (Up to 2516 fewer cases)



Value of Health Benefits from using Biodiesel at the Port of New York and New Jersey (Per Year)		
Health Impact Endpoint	**Reduced Incidence**	**Benefit Value**
Acute Myocardial Infarction Nonfatal	480.2	$15,115,170
Asthma Symptoms Albuterol use	**74,287.6**	**$25,673**
ER visits All Cardiac Outcomes	56.8	$65,966
ER visits respiratory	156.0	$136,416
HA All Respiratory	24.1	$359,484
HA Alzheimers Disease	96.6	$1,191,555
HA Cardio- Cerebro- and Peripheral Vascular Disease	25.6	$401,042
HA Parkinsons Disease	15.1	$195,970
HA Respiratory-2	3.4	$0
HA Respiratory-2 HA All Respiratory	27.5	$0
Incidence Asthma	**574.6**	**$25,658,684**
Incidence Hay Fever/Rhinitis	3,548.1	$2,128,554
Incidence Lung Cancer	29.0	$364,106
Incidence Out of Hospital Cardiac Arrest	3.5	$124,068
Incidence Stroke	11.4	$388,636
Minor Restricted Activity Days	**193,804.5**	**$13,485,269**
Mortality All Cause	**174.6**	**$1,366,431,014**
Work Loss Days	**33,296.2**	**$6,880,283**
Total		**$1,432,951,890**

Source: Health Benefits Study, Clean Fuels 2022

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STUDY SHOWS SIGNIFICANT HEALTH BENEFITS FROM B100

Switching to B100 in legacy vehicles and heating oil would:

- **Cancer cases reduced by nearly 9500 (over 70-yr timeframe)**
- **Nearly 930 fewer premature deaths/yr**
- **Over 456,000 fewer/reduced asthma cases/yr**
- **Over 142,000 fewer sick days/yr**
- **Nearly 829,000 fewer minor restricted activity days/yr**
- **$7.5 billion in avoided health costs/yr**
- These results for only 28 sites evaluated are **the tip of the iceberg**

Purdue University

Induced land use changes (ILUC) due to biofuels: Hypothetical projections versus actual observations

Farzad Taheripour

Research Professor

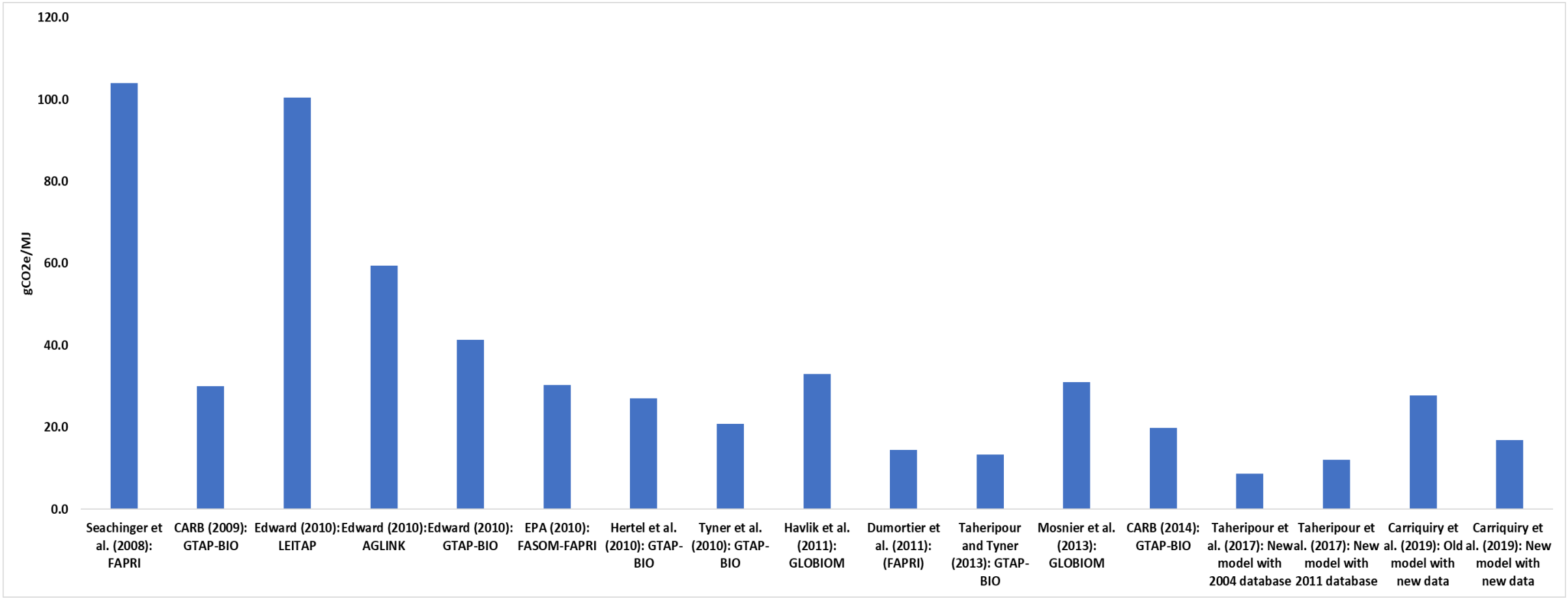
Purdue University

Department of Agricultural Economics

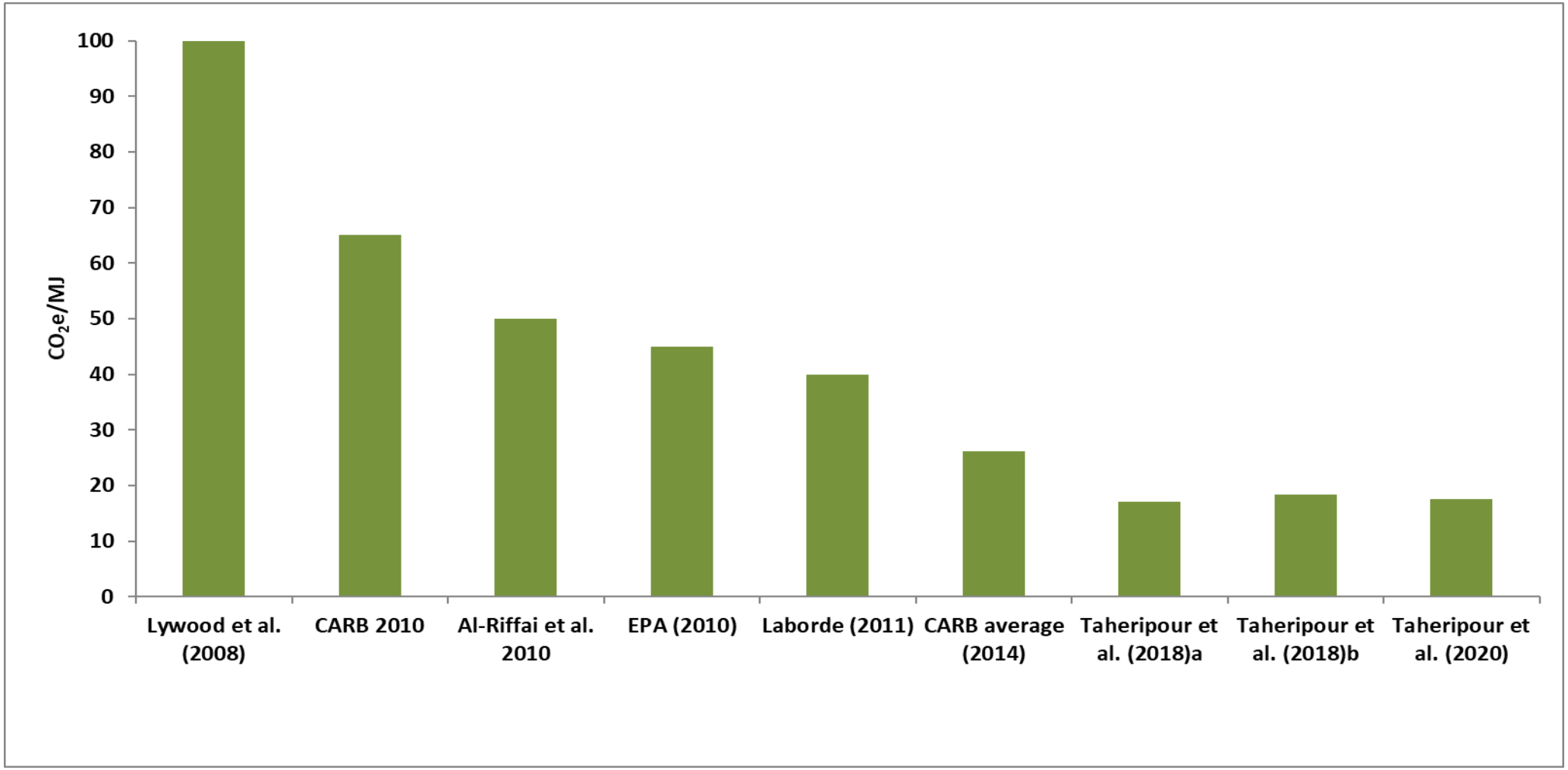
Concerns about ILUC due to biofuels

- An increase in demand for biofuels could increase demand for cropland
- Additional demand for cropland may generate deforestation and conversion of natural land in the country produced biofuels and across the world.
- The extent to which biofuel production may increase demand for cropland and cause deforestation is an important concern to be examined.
- Some early research on this topic projected that biofuel production in the U.S. could lead to major deforestation and that generates a large ILUC emissions.
- However, more advanced research and historical observations do not support projections made by the early papers in this area.

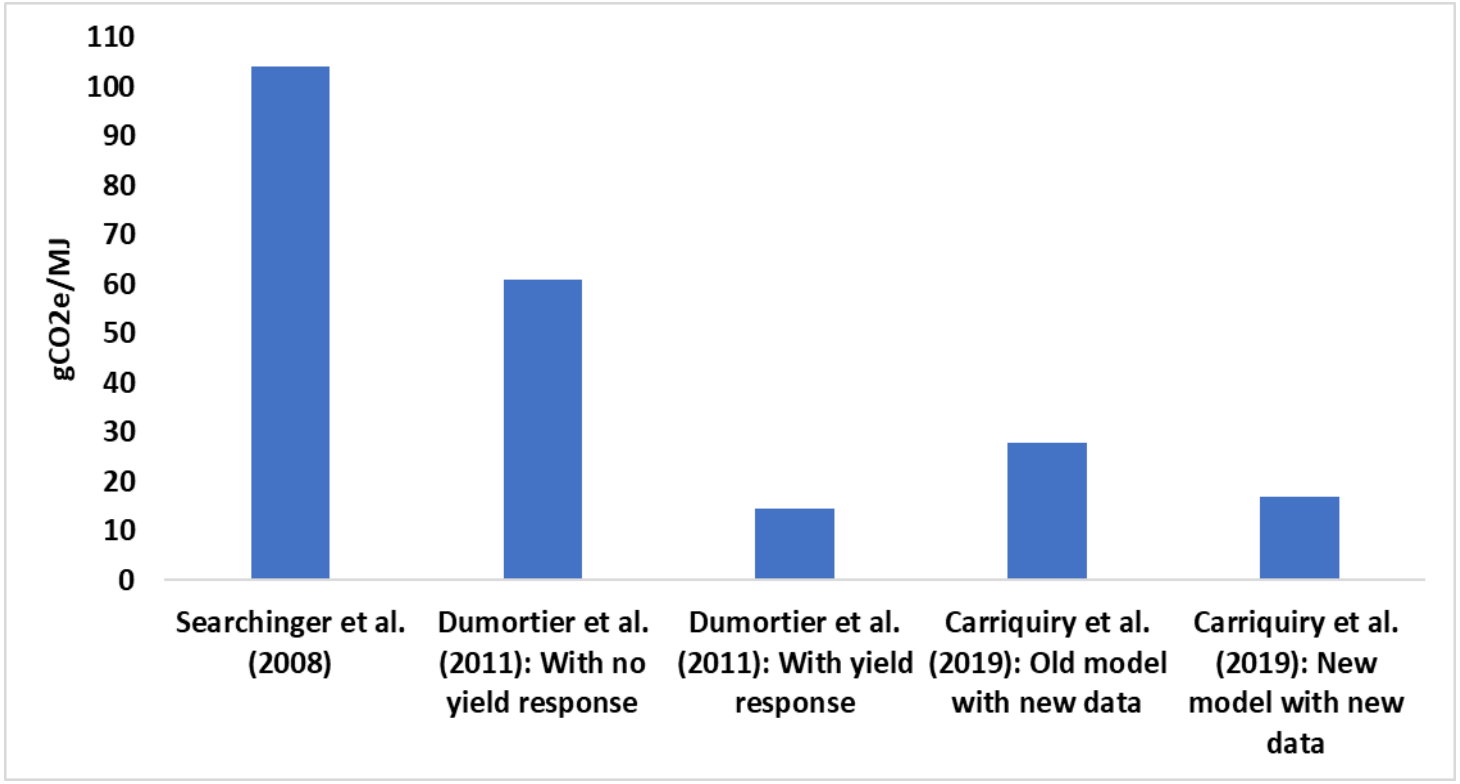
Review of estimated ILUC values for corn ethanol using various economic models



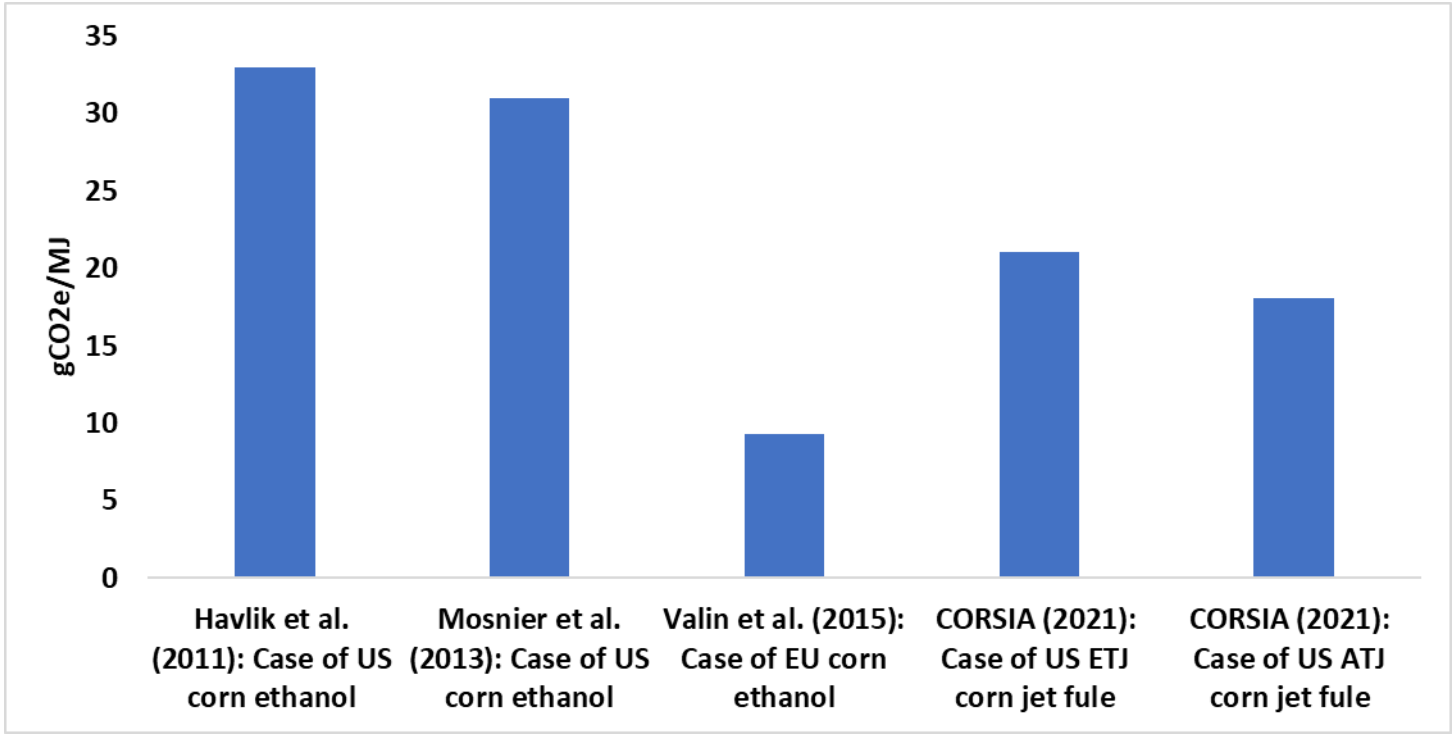
Review of estimated ILUC values for soybeans biodiesel using various economic models



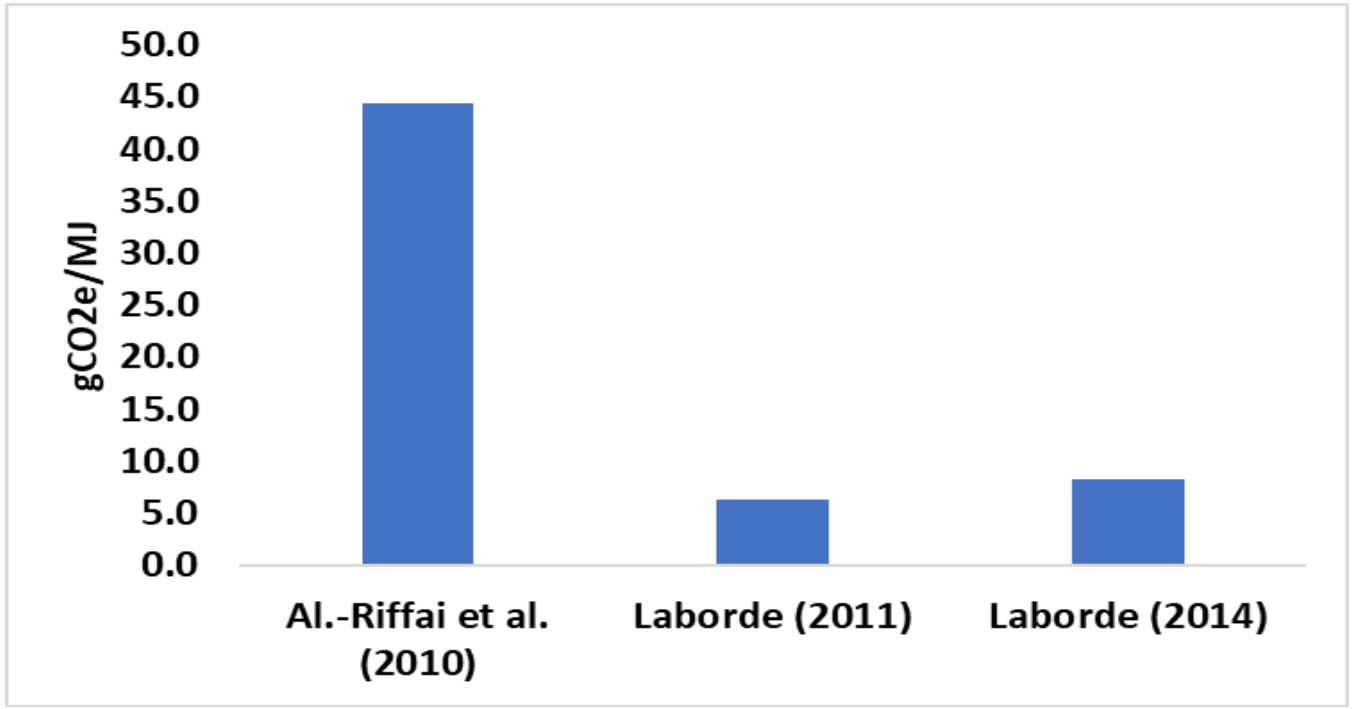
Review of estimated ILUC values for corn ethanol: FAPRI model



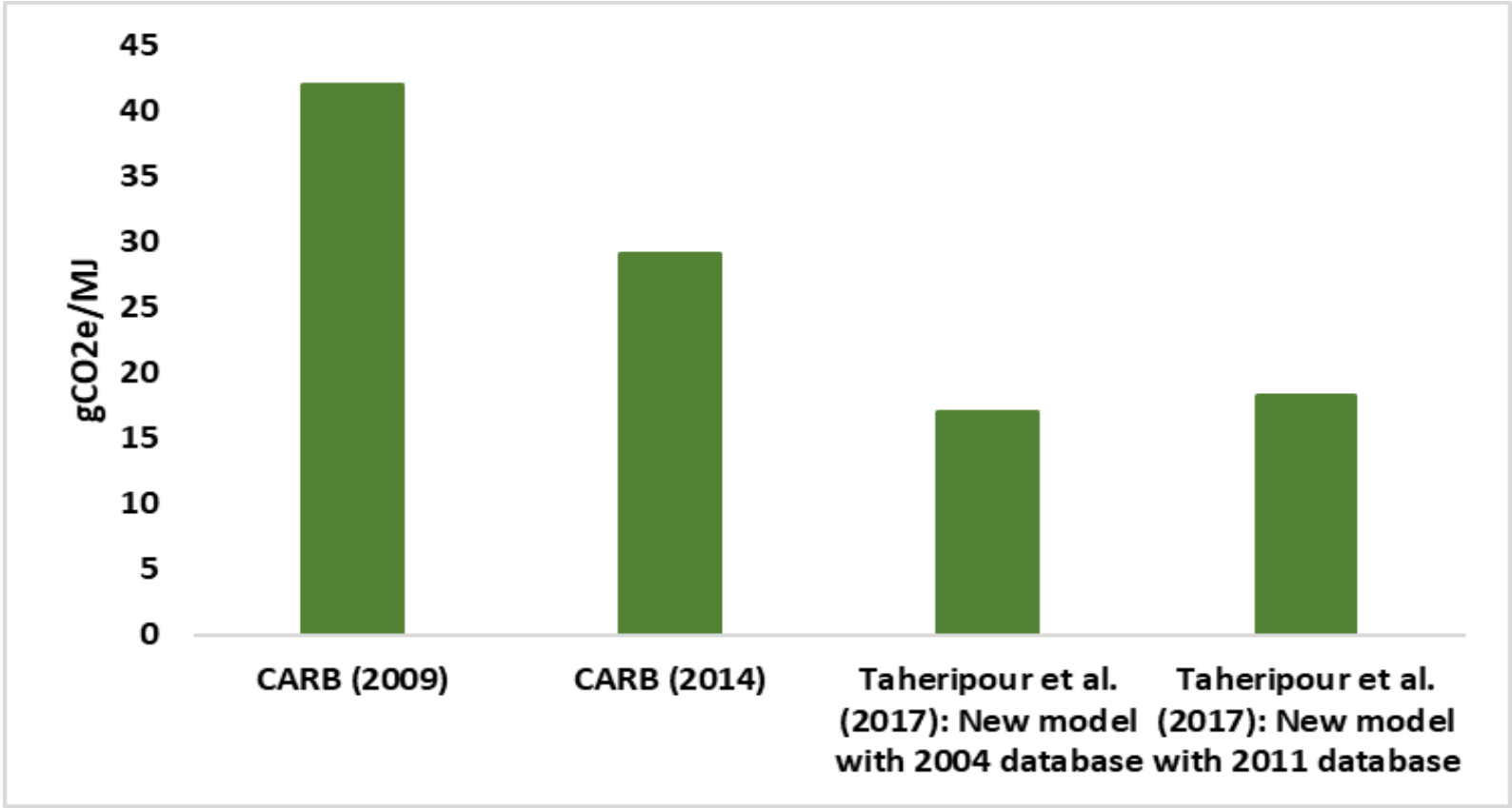
Review of estimated ILUC values for corn ethanol: GLOBIOM model



Review of estimated ILUC values for corn ethanol: MIRAGE model



Review of estimated ILUC values for soybeans biodiesel: GTAB-BIO model

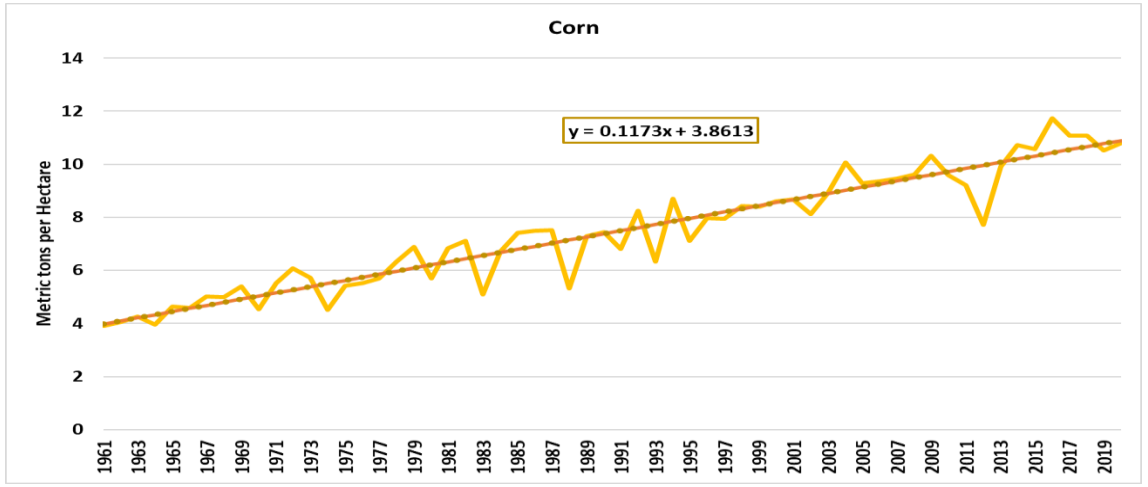


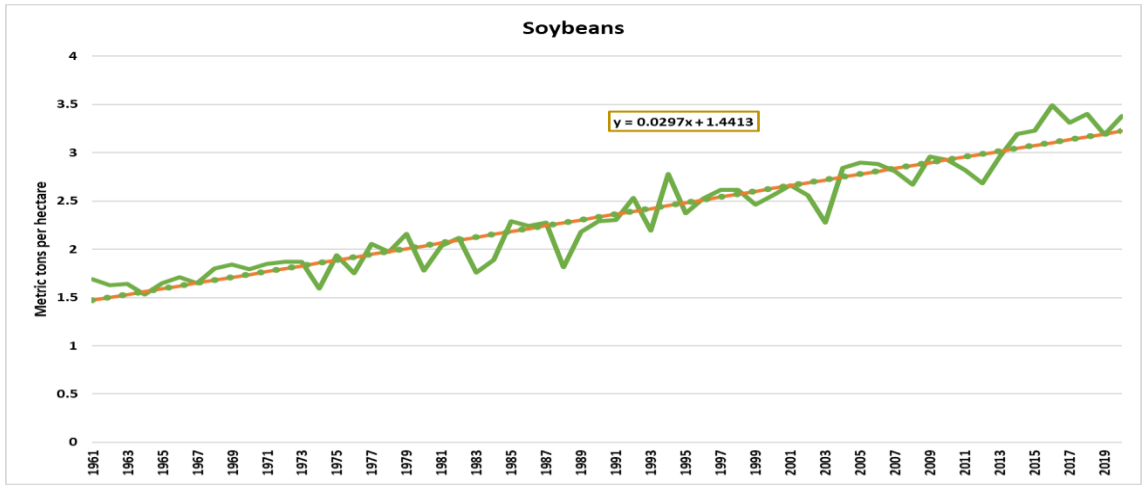
Why older versions of economic models overestimated ILUC emissions?

- Early papers on ILUC have used economic models ignoring intensifications (yield improvement, conversion of unused cropland to active cropland, double cropping) in crop production.
- More advanced and up-to-dated models have taken into account intensifications according to actual observations and project lower ILUC values.
- A large number of papers have paid attention to the fact that intensification in crop production could significantly reduce demand for cropland, regardless of the use of crops (some examples are: Cassman (1999), Brady and Sohngen,, (2008), Alexandratos and Bruinsma (2012), Alston et al. (2010), Borchers et al. (2014), Byerlee et al. (2014), Ausubel et al. (2012), and Hertel and Baldos (2016).

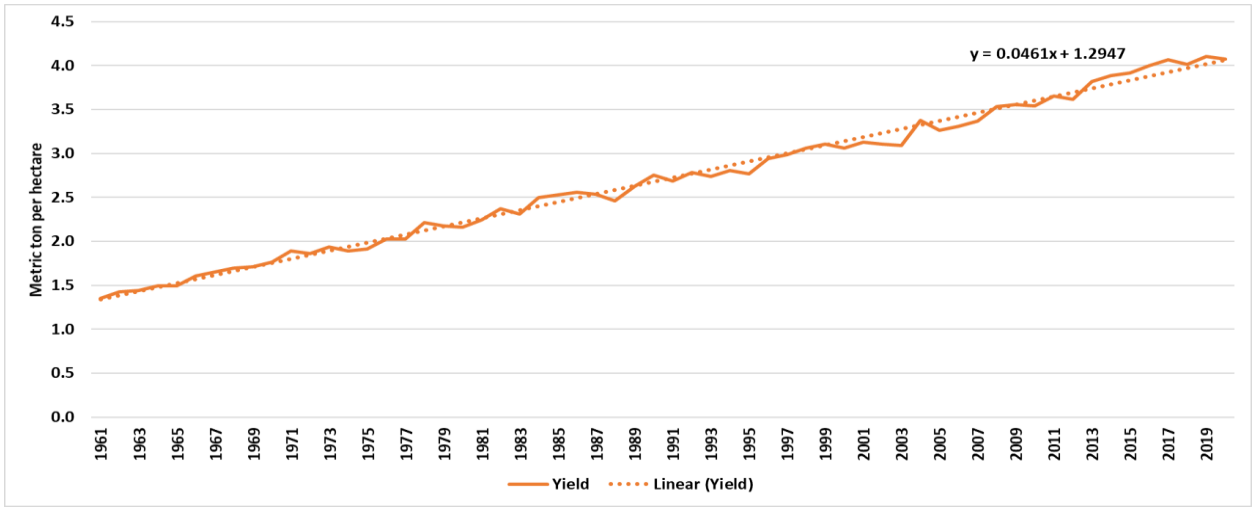
Productivity improvement in crop production in the US and across the world

Historical observations on corn and soybeans yields since 1961





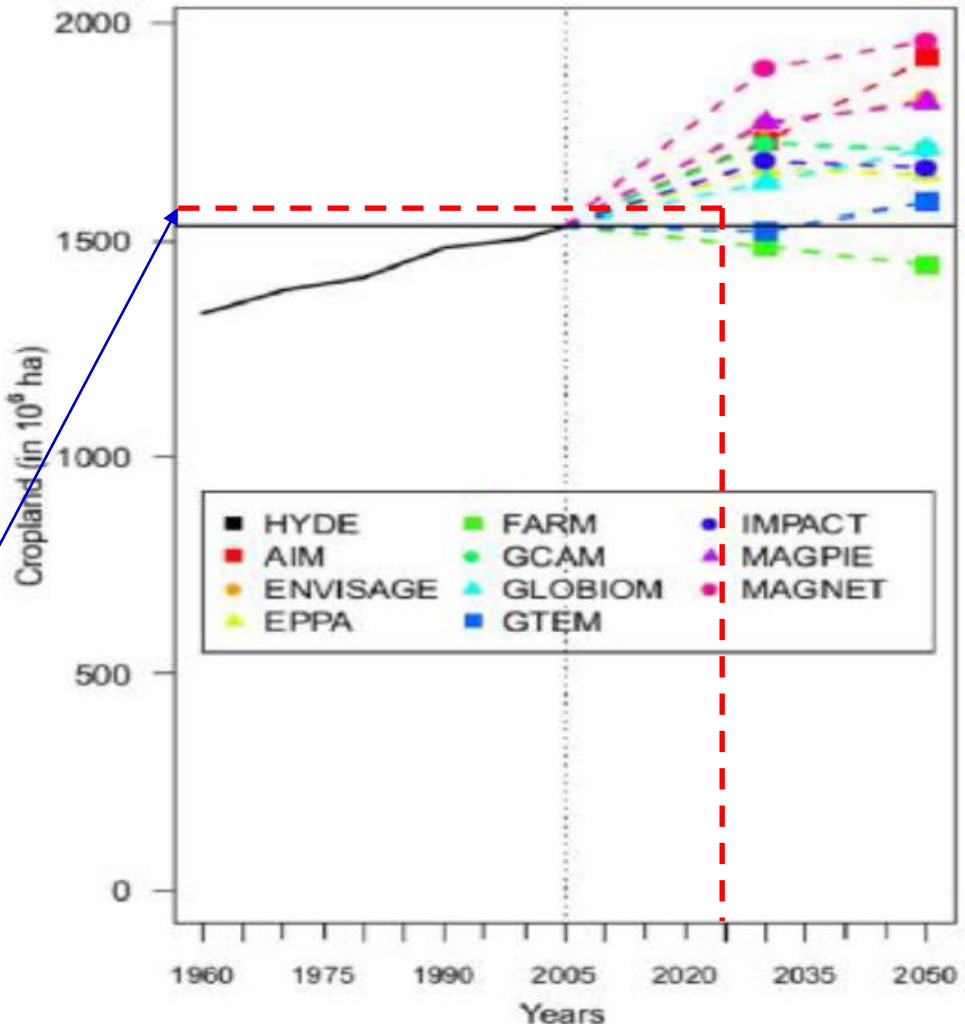
Historical observations on cereals yield improvement at the global scale



- Between 2000-2020 corn yield has increased by 27.5% in the US .
- Between 2000-2020 soybean yield has increased by 22.6% in the US.
- Over time major productivity improvements occurred across the world.
- **Productivity gains provided major saving in land use**

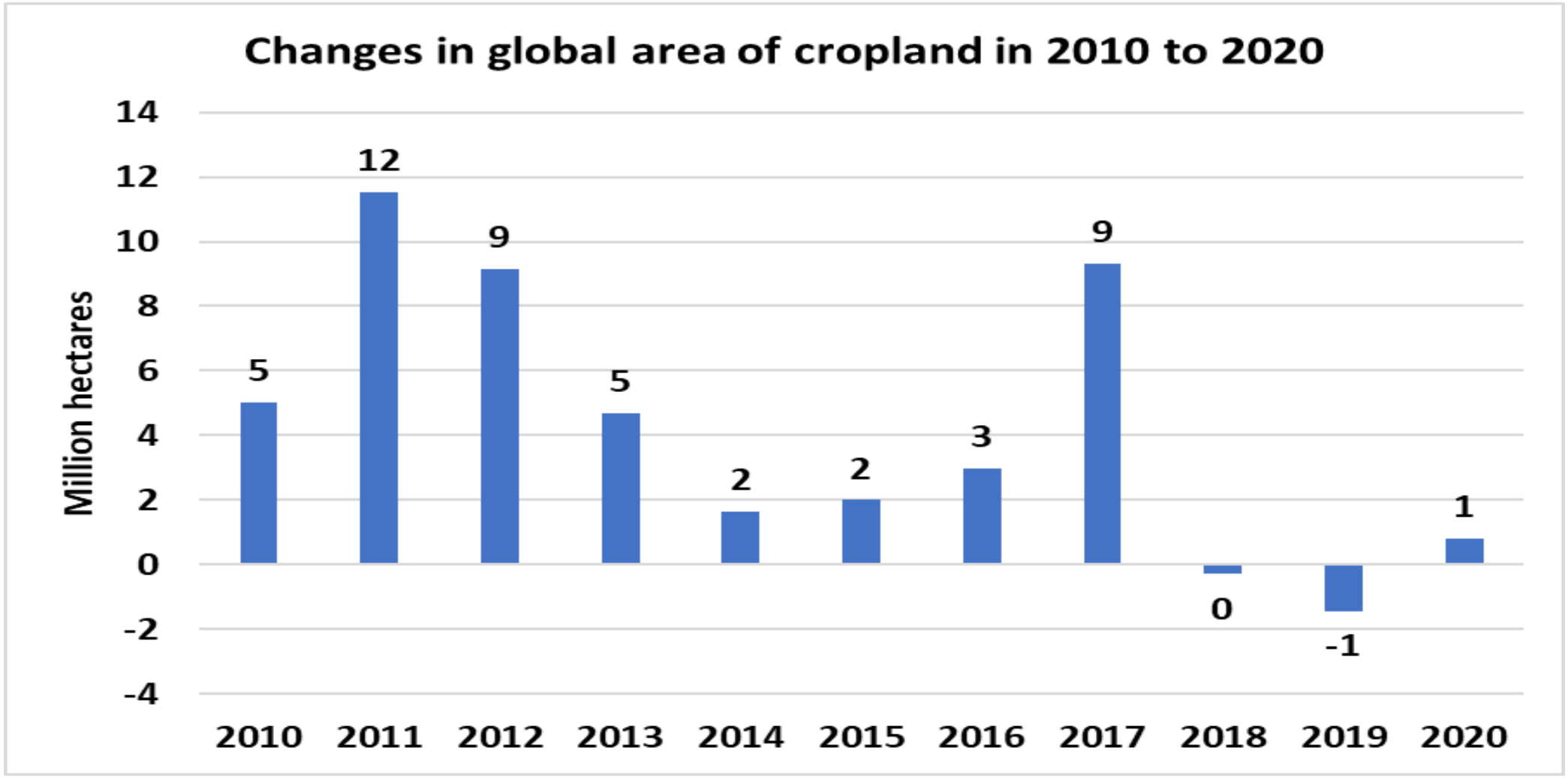
Economic models could badly overestimate demand for cropland

- In his presentation for this committee, Dr. Searchinger has referred to Schmitz et al. (2015) and mentioned that *"Nearly all studies project more cropland for food by 2050"*
- The chart provided by Schmitz et al. (2015) is modified to show that most of the models used by these authors badly overestimated demand for cropland for 2020 according to the observed global area of cropland in this year.

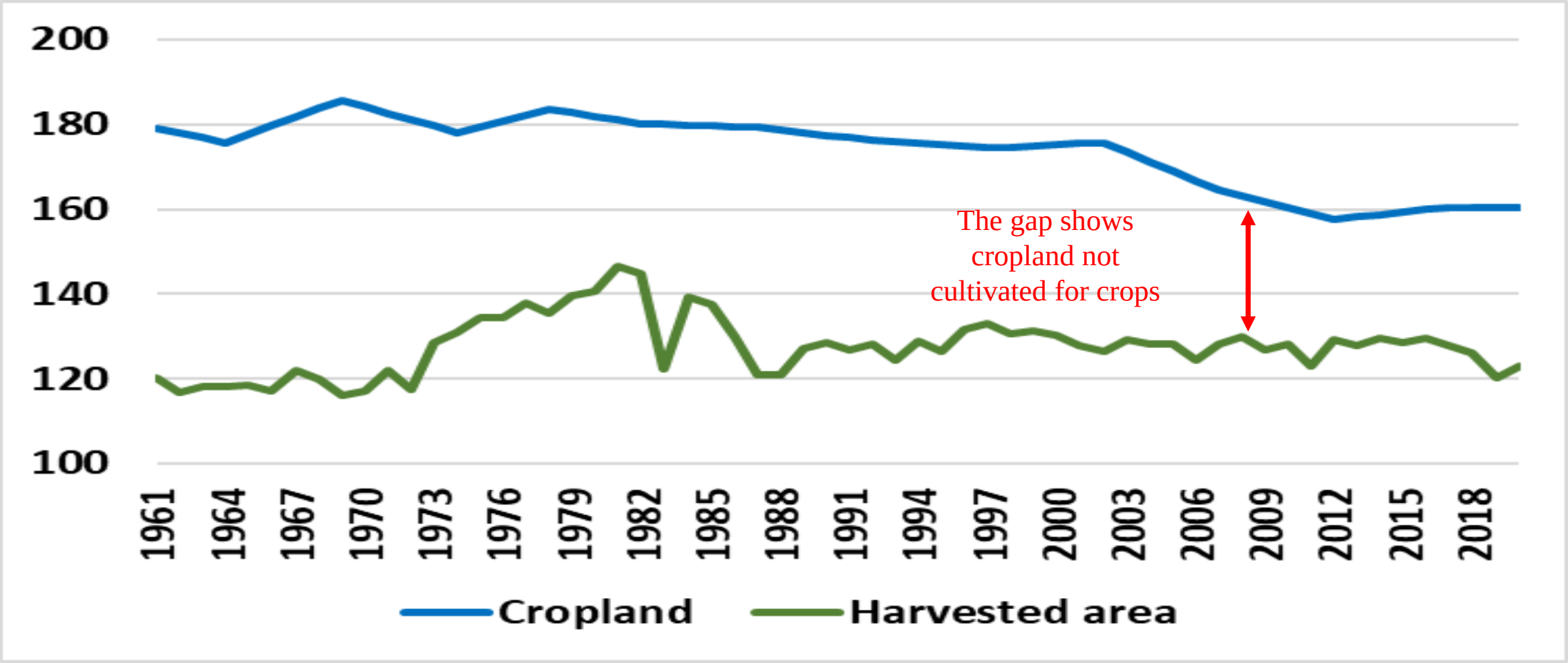


Global area of cropland in 2020 according to FAO data

FAO data does not show a major expansion in cropland in 2010-2020



A large area of cropland is available in the US to produce feedstock for various types of biofuels and save GHG emissions



Thanks

Questions and Comments

Clean Fuels Alliance America

Clean Fuels
ALLIANCE AMERICA

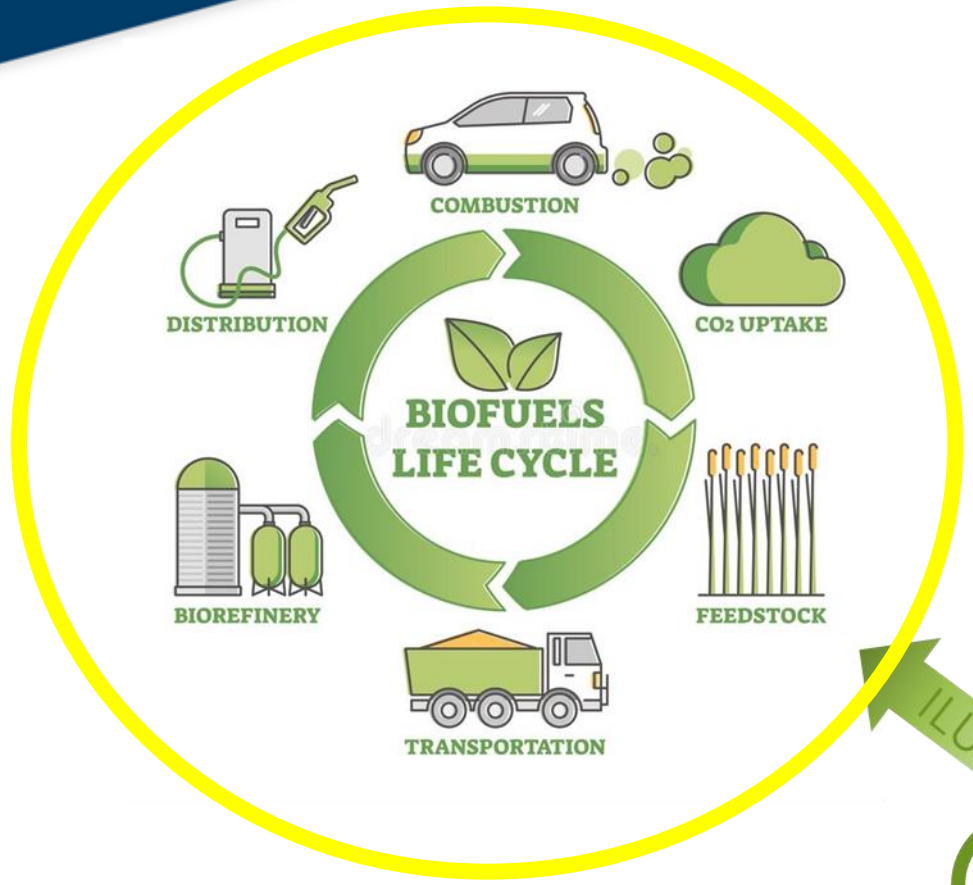
REDUCING LIFE CYCLE EMISSIONS TO DECARBONIZE TRANSPORT

Veronica Bradley, Director of Environmental Science

Clean Fuels ALLIANCE AMERICA

LIFE CYCLE EMISSIONS

AKA cradle-to-grave
AKA well-to-wheels/wake
AKA carbon intensity
AKA carbon score



ILUC

Policy-based consideration that applies to crop-based fuels only

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LIFE CYCLE ASSESSMENT BACKGROUND

- Life cycle assessments more broadly assess the environmental burdens of products from the production of the final product's ingredients through all the steps in the supply chain to the finished product and its end-of-life fate in society
- Direct life cycle emissions focus on the GHG emissions associated with each of those steps allocating emissions to the specific product in question relative to other co-products that come out of the same production processes

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HOW DO WE CALCULATE DIRECT LIFE CYCLE EMISSIONS?

- Boundaries must be set on how far upstream and downstream to go when calculating emissions

For bio-based fuels, generally, boundaries are set to include GHG emissions from:

- Inputs' production (e.g., fossil energy inputs to make fertilizer or natural gas, electric grid mix)
- The processes undertaken in each life cycle step (e.g., fertilizer application to grow soy, transportation between field and fuel production facility, feedstock-to-fuel conversion process)

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HOW DO WE CALCULATE DIRECT LIFE CYCLE EMISSIONS?

- Distinctions on upstream system boundary among feedstocks
  - Agricultural feedstocks include the inputs to growing the commodity
  - Waste feedstocks include collection of the waste and processing it into a usable feedstock
- Calculate GHG emissions associated with each step following IPCC methodologies
- Decide allocation of process emissions
  - E.g., mass, energy, market base

HOW DO WE CALCULATE LIFE CYCLE EMISSIONS?

- Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) Model is best option to assist
  - Open-access model created and maintained by the U.S. DOE Argonne National Lab
  - Provides a complete picture of the energy and environmental impacts of technologies, including well-to-wheels GHG emissions for fuels
  - Allows users to capture full suite of emission reduction opportunities throughout the supply chain to reduce fuels' life cycle emissions
  - Regularly updated with latest scientific and industry information
  - Most current regulatory programs rely on the GREET model in some capacity: CA-LCFS, EPA RFS, ICAO CORSIA

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CONNECTICUT'S OPPORTUNITY

- The State can use the GREET model to easily calculate life cycle emissions for any low-carbon fuel program by incorporating it by reference
  - Allows updates to the science to be incorporated without costs to the State
  - Allows fuel producers transparency to drive further emission reductions
  - Captures ILUC emissions for crop-based feedstocks through CCLUB module

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USE OF GREET EXTENDS EMISSION REDUCTION IMPACTS

CARBON EMISSION CONTRIBUTIONS	GREET	Ca. GREET 3.0	CORSIA	RFS	EU REDII	Canada CFS	RenovaBio
Farm Specific Cultivation	✓	✗	✓	✗	✓	✓	✓
iLUC Updated Land Use Data	✓	✗	✗	✗	✓	N/A	N/A
Land Management Changes	✓	✗	+/-	✗	✓	✓	✓
Carbon Capture and Sequestration Crediting	✓	✓	✗	✓	✓	✓	✓
Electricity Source	✓	✓	✓	✓	✓	✓	✓
Thermal Source	✓	✓	✓	✓	✓	✓	✓
Methane Avoidance for Manure Systems	✓	✓	✗	✓	N/A	N/A	N/A
Hydrogen Source	✓	✓	✓	✓	✓	✓	✓

✓Always calculated ✗ Not calculated +/- Carbon emission calculated if positive, and not if negative N/A Not within system boundary

THIS GRAPHIC REFLECTS CURRENT REGULATIONS AS OF MARCH 2022

Source: https://gevo.com/why-biofuels/why-biofuels-make-sense/gevo-believes-argonne-greet-is-the-superior-model/

QUESTIONS?

VERONICA BRADLEY, DIRECTOR
ENVIRONMENTAL SCIENCE

VBRADLEY@CLEANFUELS.ORG

Clean Fuels
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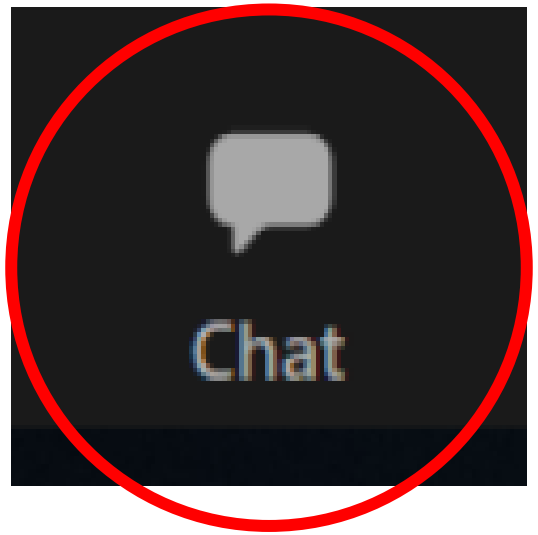
Questions



At the conclusion of each panel DEEP will hold a brief question and answer period.

If you have a question for a presenter, please drop it into the chat to **Jeff Howard**. DEEP will pose as many questions as time allows to the speakers. Clarifying questions will be prioritized. Leading questions will not be accepted.

Proposals for CT's Path Forward

Franz Litz – Litz Energy Strategies

Matt Golden – Recurve

Audrey Schulman – Home Energy Efficiency Team (HEET)

Jim Koontz – Reliable Secure Power Systems (RSP Systems)

Molly Connors – New England Power Generators Association (NEPGA)

Joe Uglietto – Diversified Energy Specialists *[Unable to present during the live session but slides are included in this deck for viewing]*

Click on an agenda section heading to jump to the relevant slides

(speaker order may vary)

BUREAU OF ENERGY AND TECHNOLOGY POLICY

Litz Energy Strategies

THREE MARKET-BASED POLICIES TO CONSIDER

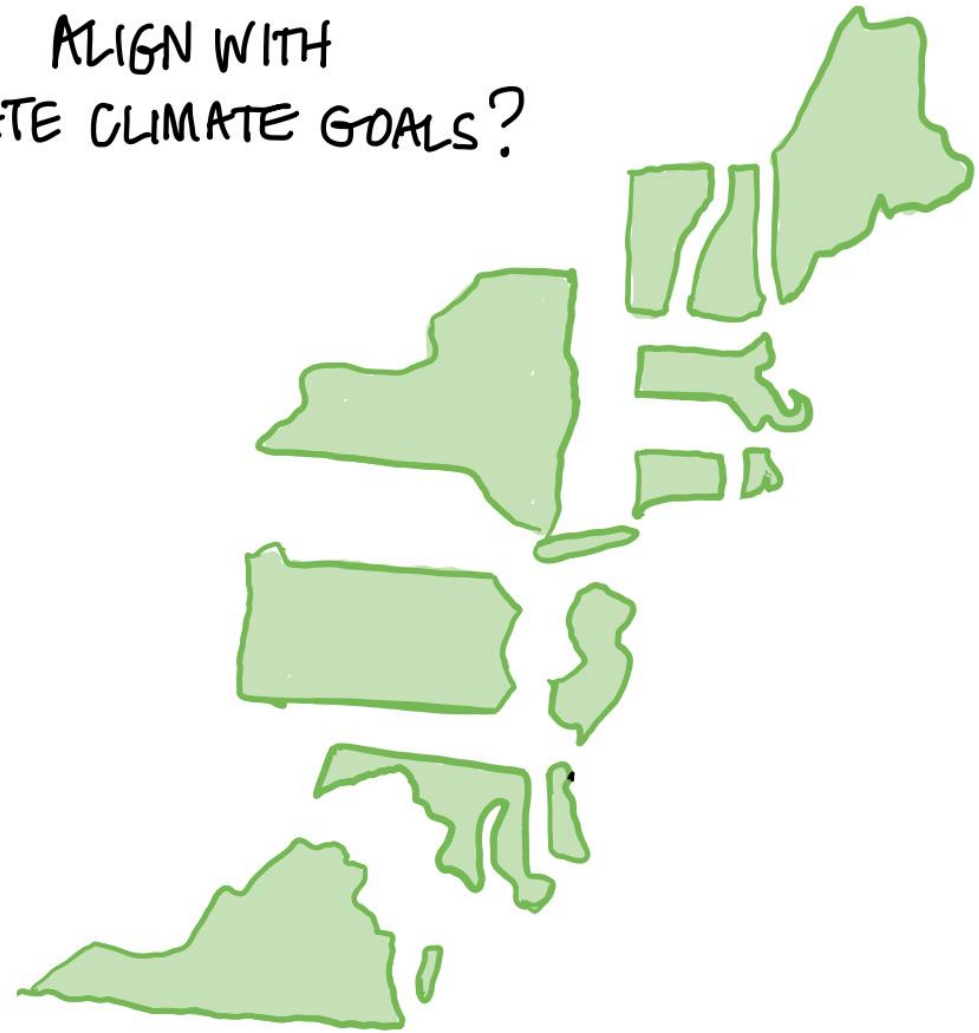
Franz T. Litz

Litz Energy Strategies LLC

franz@litzstrategies.com

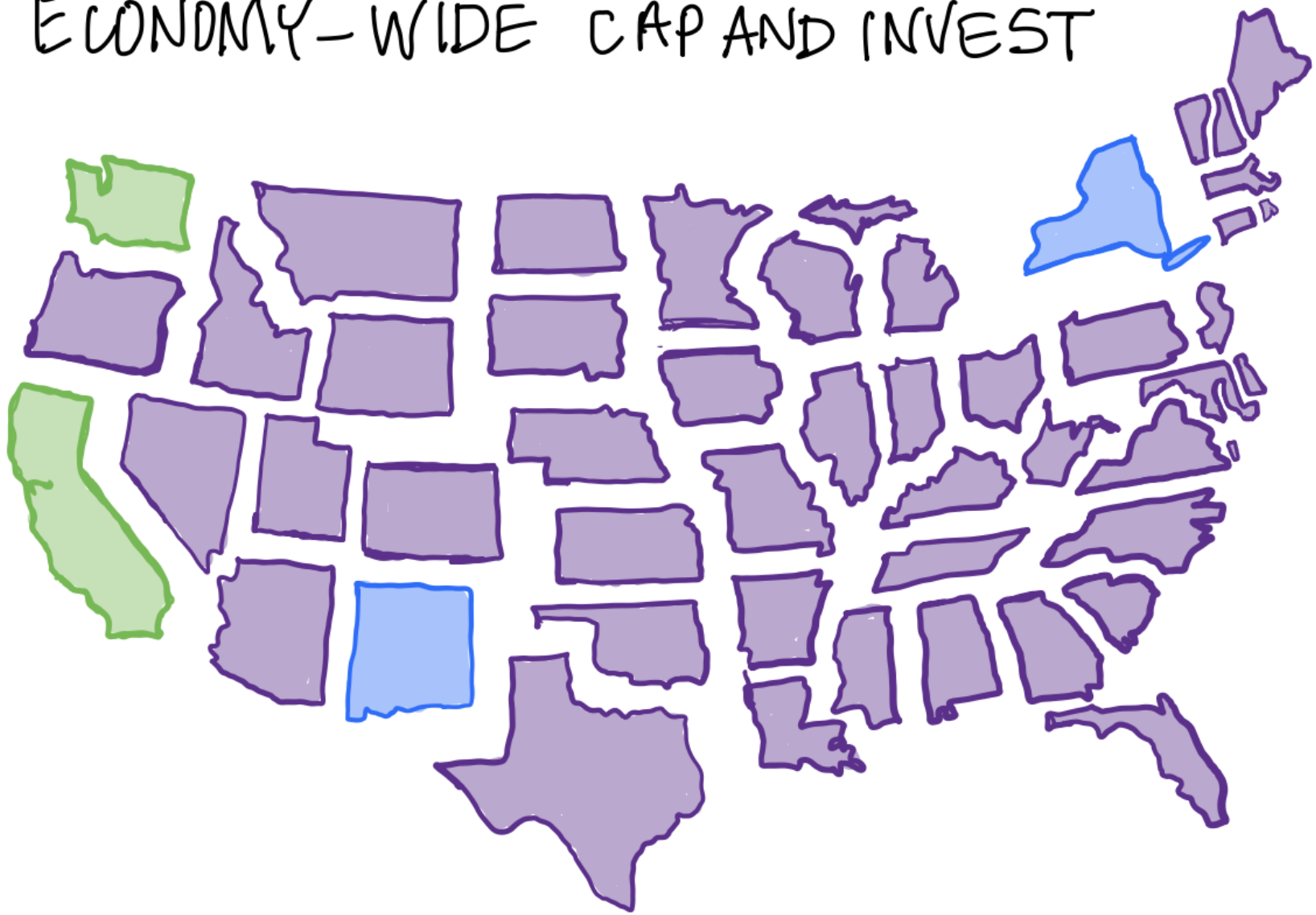
RGGI PROGRAM REVIEW

ALIGN WITH
STATE CLIMATE GOALS?

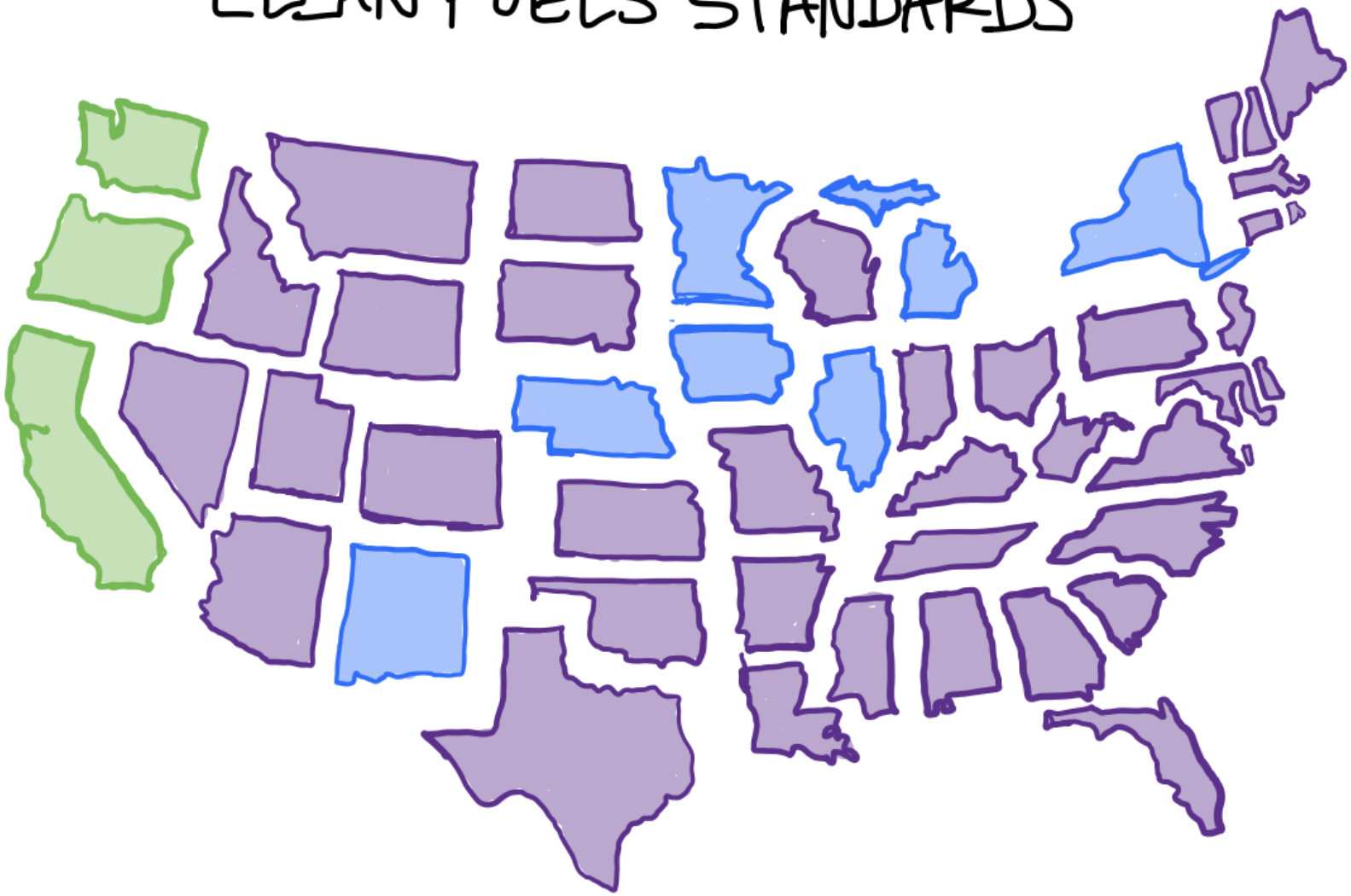


STATES CONSIDERING

ECONOMY-WIDE CAP AND INVEST



STATES CONSIDERING CLEAN FUELS STANDARDS



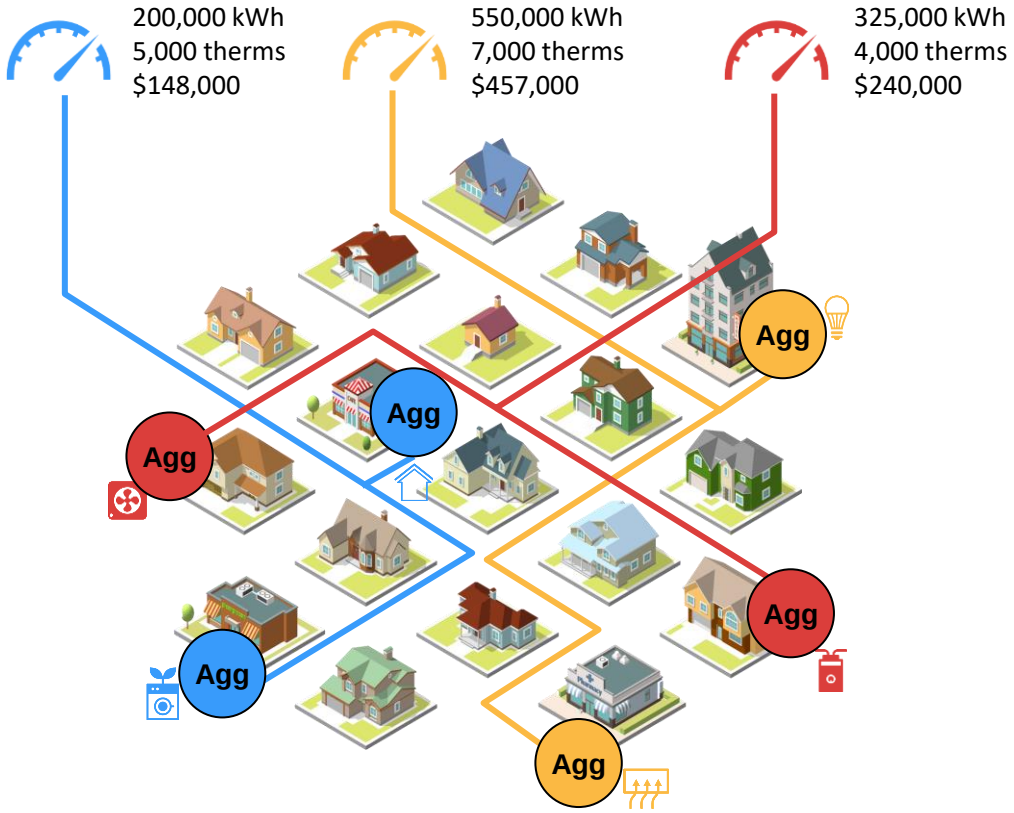
Recurve


RECURVE
SHAPE THE FUTURE OF ENERGY

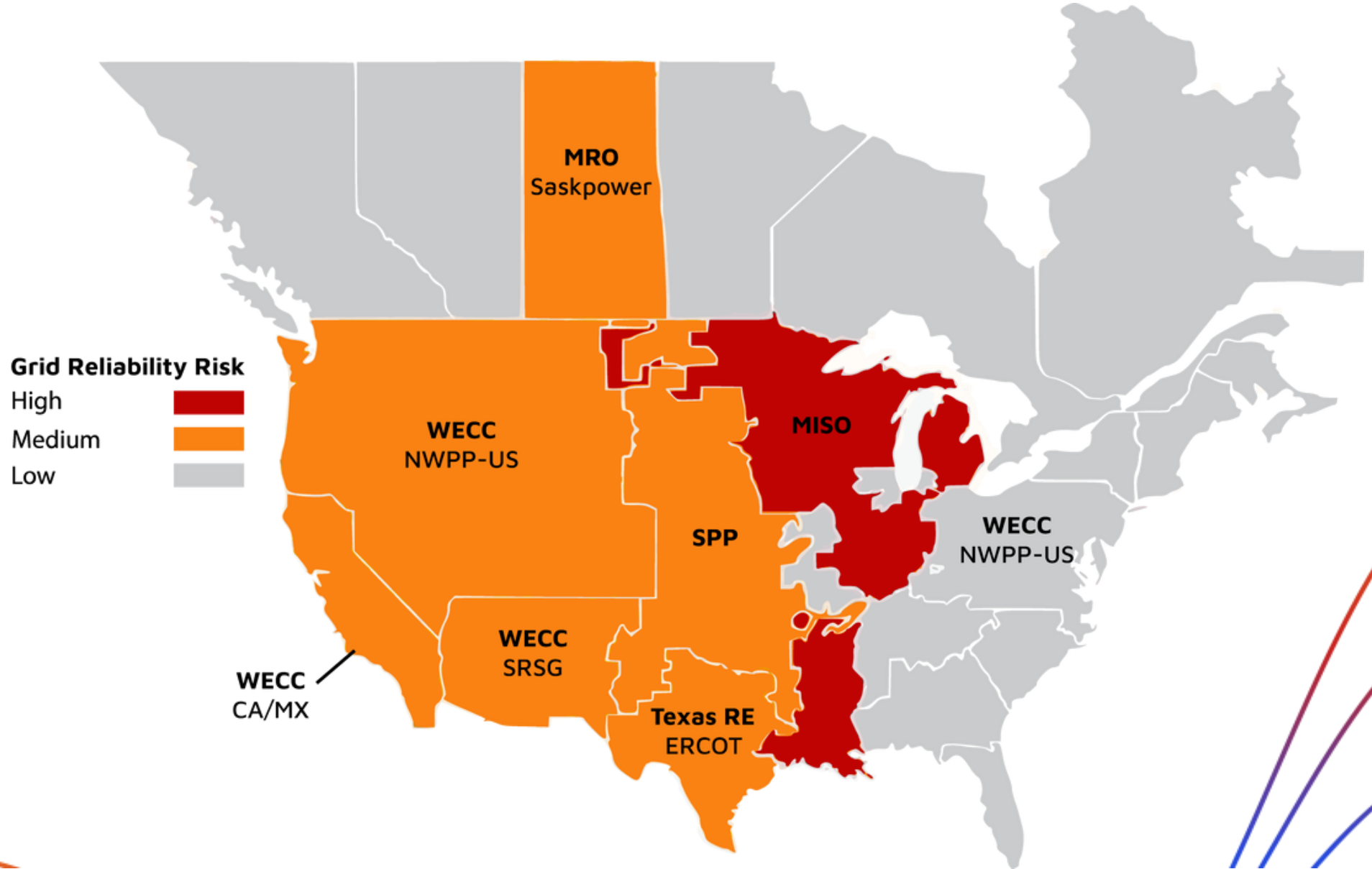
What Does Recurve Do?

1. Demand Flexibility Analytics Platform

2. Market for Virtual Power Plants



Coming to a grid near you…



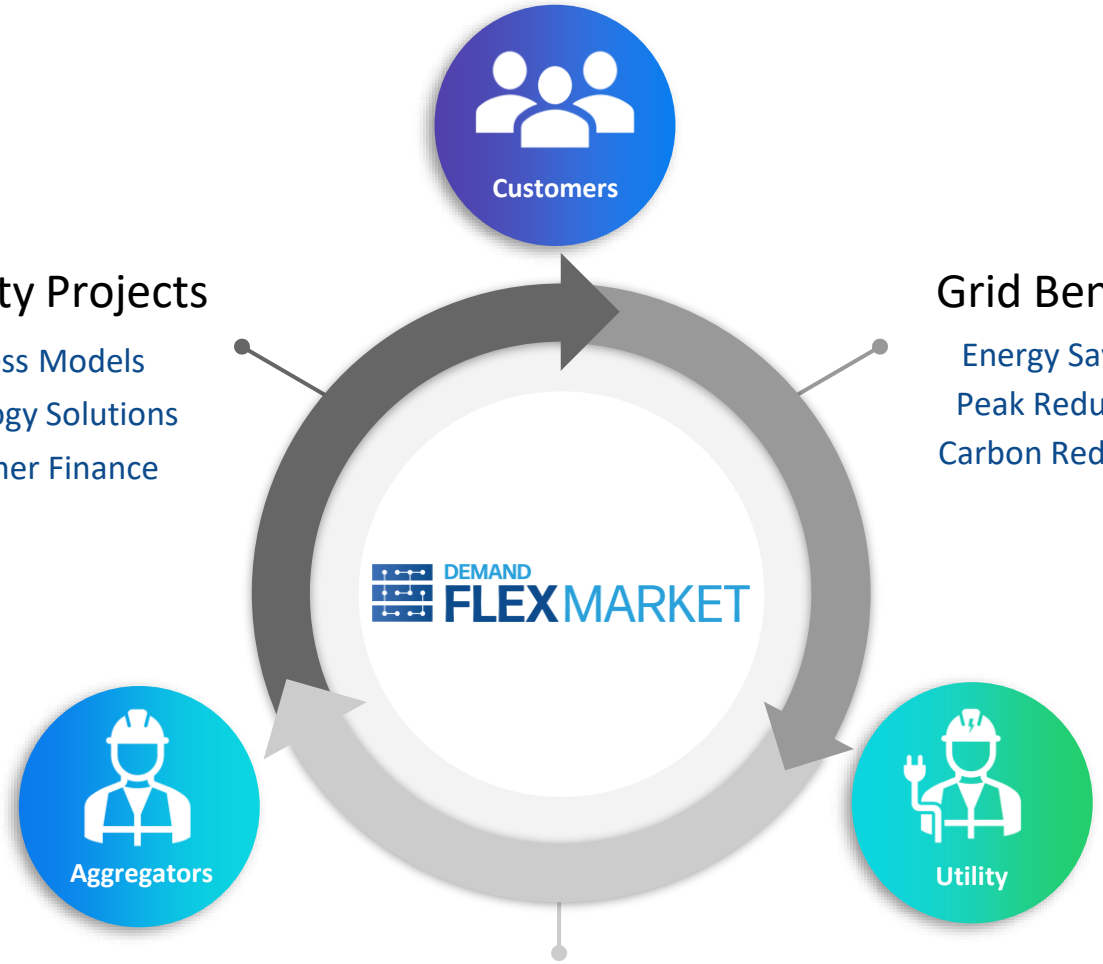
Why Market Access?

California governor moves to free up electricity supply amid projected 3.5 GW summer shortfall

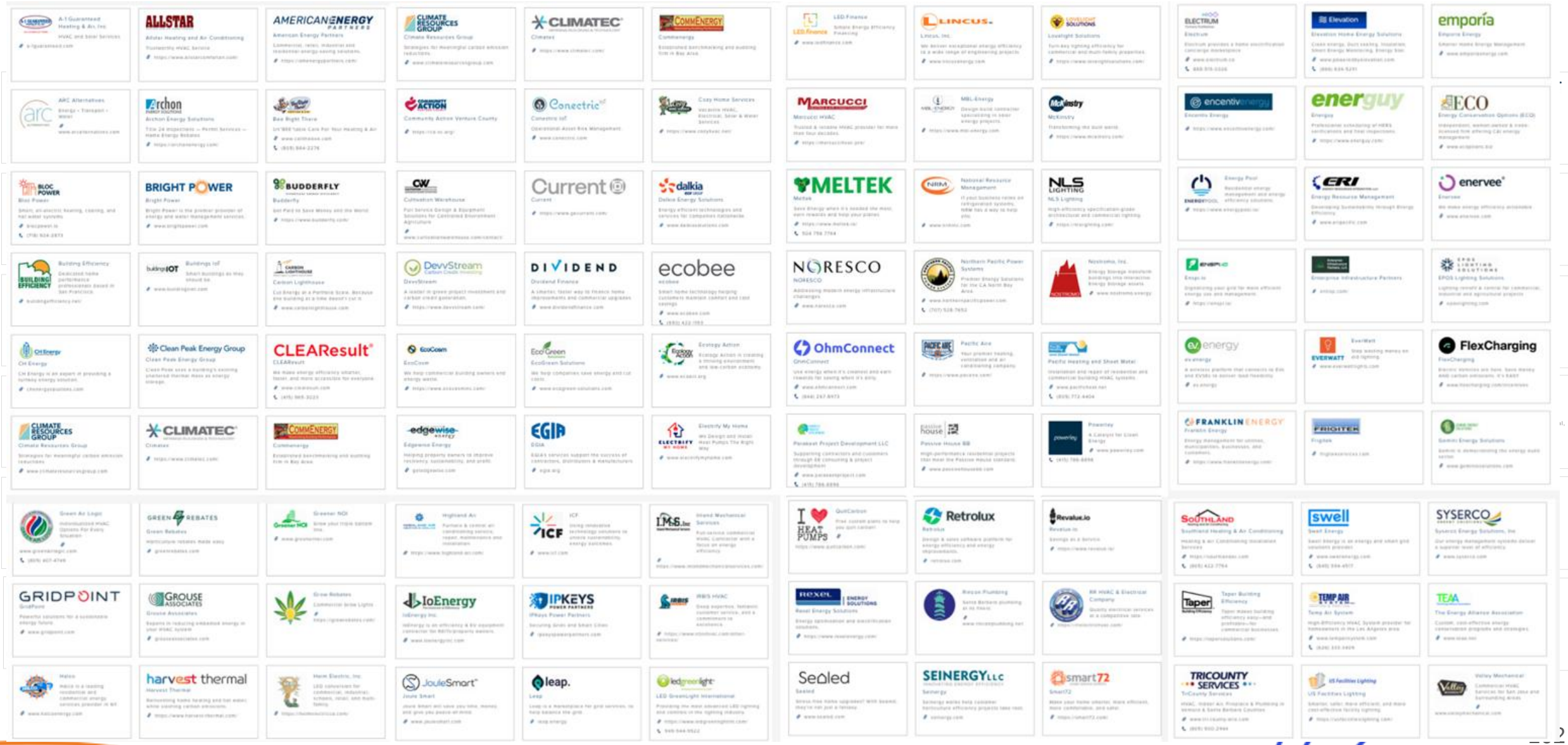
Published Aug. 3, 2021

Kavya Balaraman
Senior Reporter

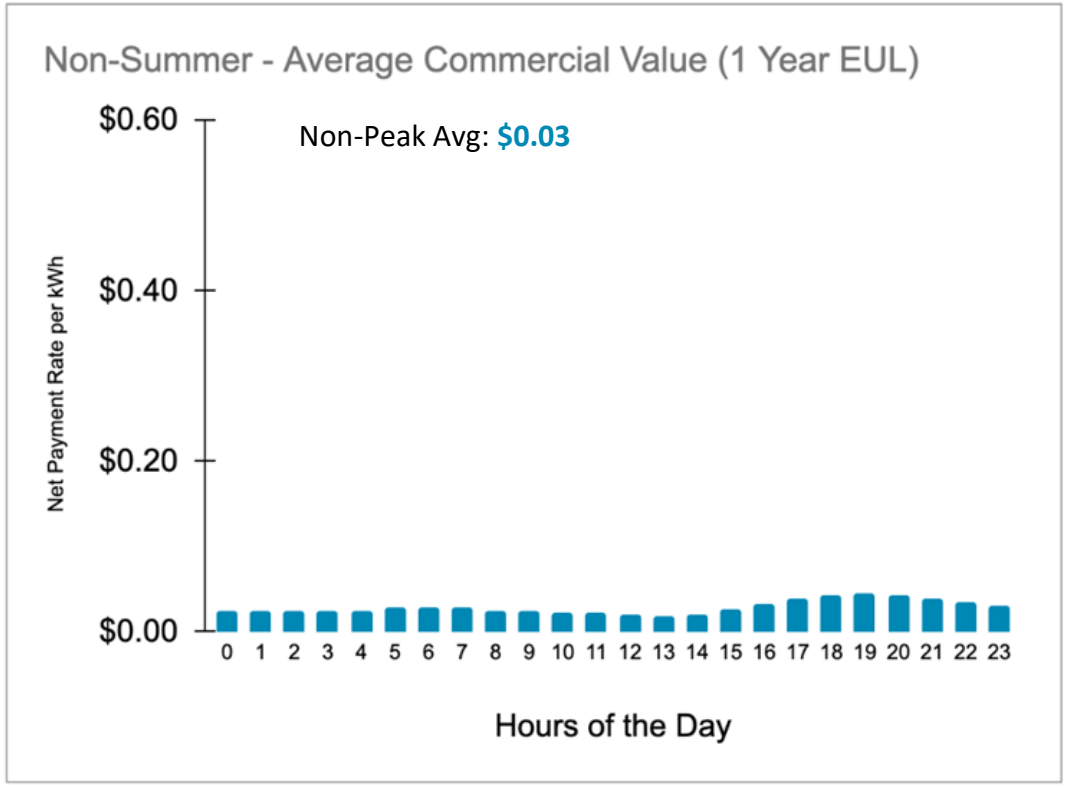
Demand FLEXmarket

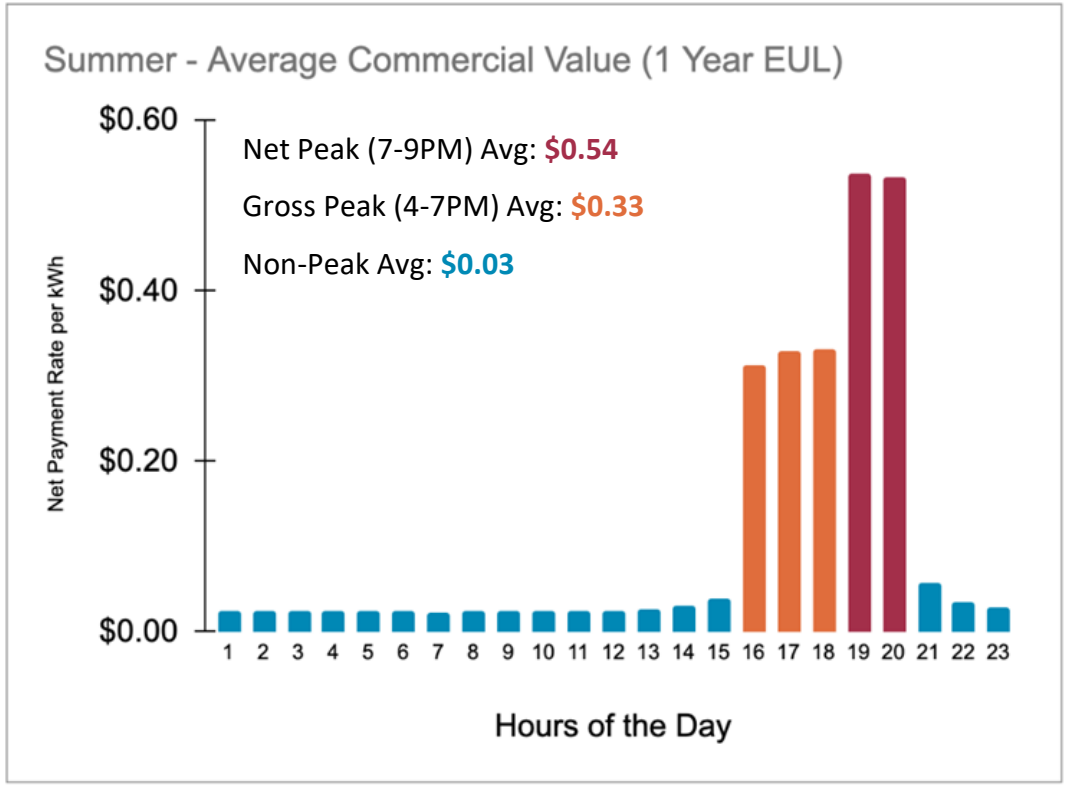


Who Are FLEXmarket Aggregators?



Example: Controls / Shifting Market Access Value (1-Year)





+

Natural Gas Reduction ACC Value

2022 FLEXmarkets

PG&E Market Access

Sectors:
Commercial

Launch Date:
May 2022

MCE

Launch Date: April-June 2022

Sectors:
Commercial, Residential, and Peak

Note: Available pathway for event response at a rate of $2,000/MWh

PCE

Launch Date: July-August 2022

Sectors:
Residential, possibly Commercial, Peak launching in 2023

SCP

Launch Date: July-August 2022

Sectors:
Residential, possibly Commercial

BayREN

Launch Date: June 2022

Sector: Small/Medium Business with a focus on Hard-to-Reach

Launch Gas ACC Multipliers:
3X Market Customers
7.5X for “Hard-to-Reach”

3C-REN

Launch Date: April 2022

Sector: Single-Family Residential with a focus on Hard-to-Reach

Launch Gas ACC Multipliers:
3X Market Customers
7.5X for “Hard-to-Reach”

Electrification Pathway:
Resets Electric Multiplier to 1X.

Inflation Reduction Act

Energy Efficiency 4.3B: Two Accelerate Energy Efficiency

- Measured Performance pays for savings using Open-Source advanced M&V
- Single and multifamily buildings with a 2x multiplier for low income
- Can utilize existing programs and utilities as aggregators for rapid deployment
- Stackable funding increases customer incentives and lowers ratepayer costs
- Works with monthly or smart meters
- Utilities can provide measurement eliminating data barriers
- Low risk as taxpayer dollars pay only for measurable outcomes

How it Works: kWh Payable Rate

Pay for Measured Savings based on Monthly Payable Rate

State	CT
Estimated SEP Budget Allocation	**$49,830,560**
Avg. Annual kWh Consumption	**8,433** kWh
Avg. Annual Therms Consumption	**875** Therms
Avg Annual Total Consumption	**34,080** kWh
$/kWh Equivalent Incentive Rate	**$0.29** kWh
$/kWh Equivalent LMI Incentive Rate	**$0.59** kWh
$/Therm Incentive Rate	**$8.60** Therm
$/Therm LMI Incentive Rate	**$17.19** Therm

Incentive Rate based on 20% of energy in average home in state, divided into $2,000 or $4,000 for low income customers.

Market Rate pays upto 50% of project cost and upto 80% for low income.

Portfolios must reduce by 15%.

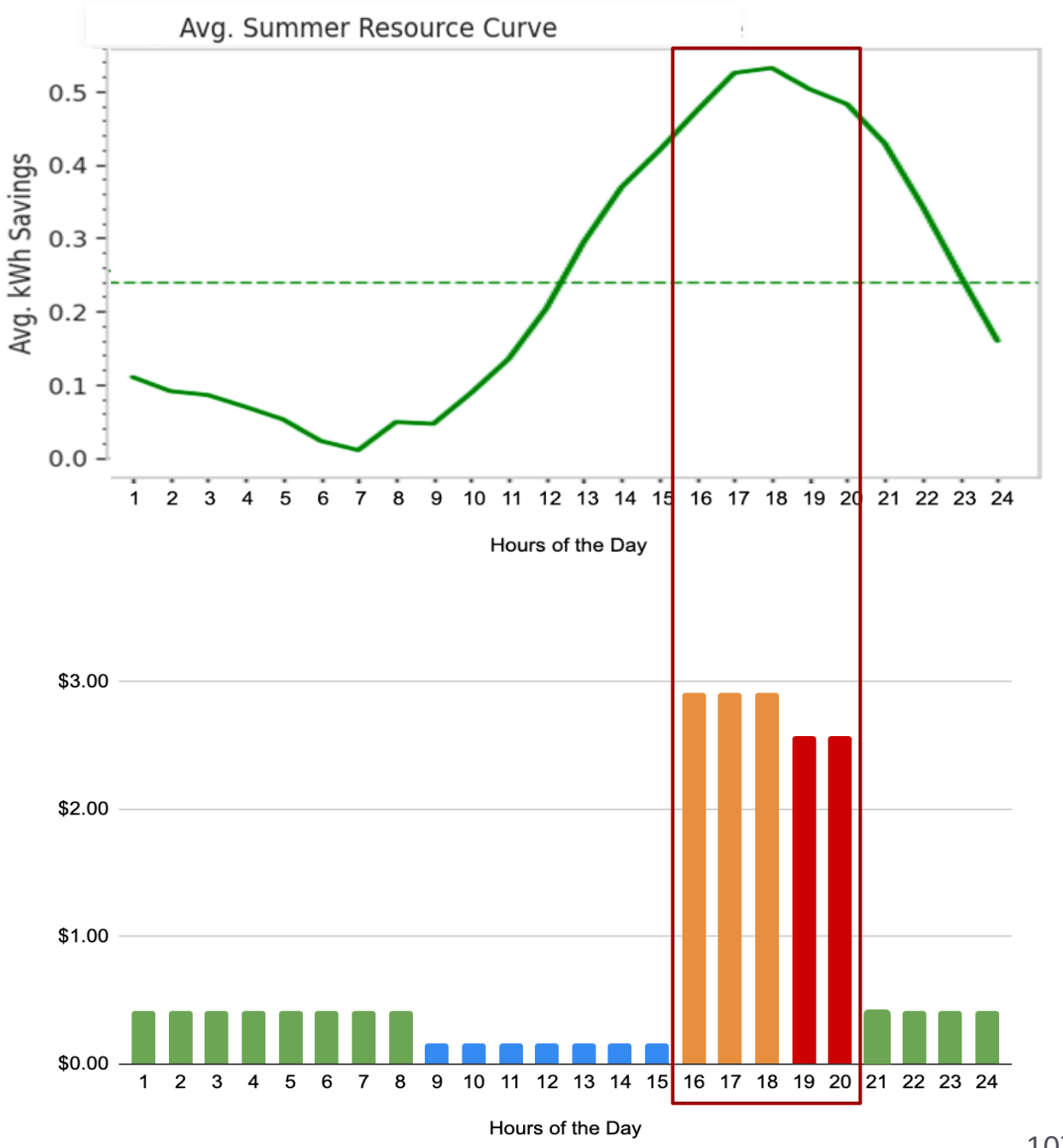
$$\textbf{Incentive Rate} = \frac{\textbf{\$2,000 or \$4,000}}{\textbf{(20\% * Avg. State Res Energy Usage)}}$$

State Calculator

IRA Homes Measured Performance Hourly Value

California IRA Example: Hourly Rates Based on [Avoided Cost Values]

Hourly Payable	Market	LMI	
Gross Peak	**$1.68**	**$3.36**	kwh
Net Peak	**$1.49**	**$2.98**	kwh
Midday	**$0.09**	**$0.18**	kwh
Off Peak	**$0.24**	**$0.49**	kwh



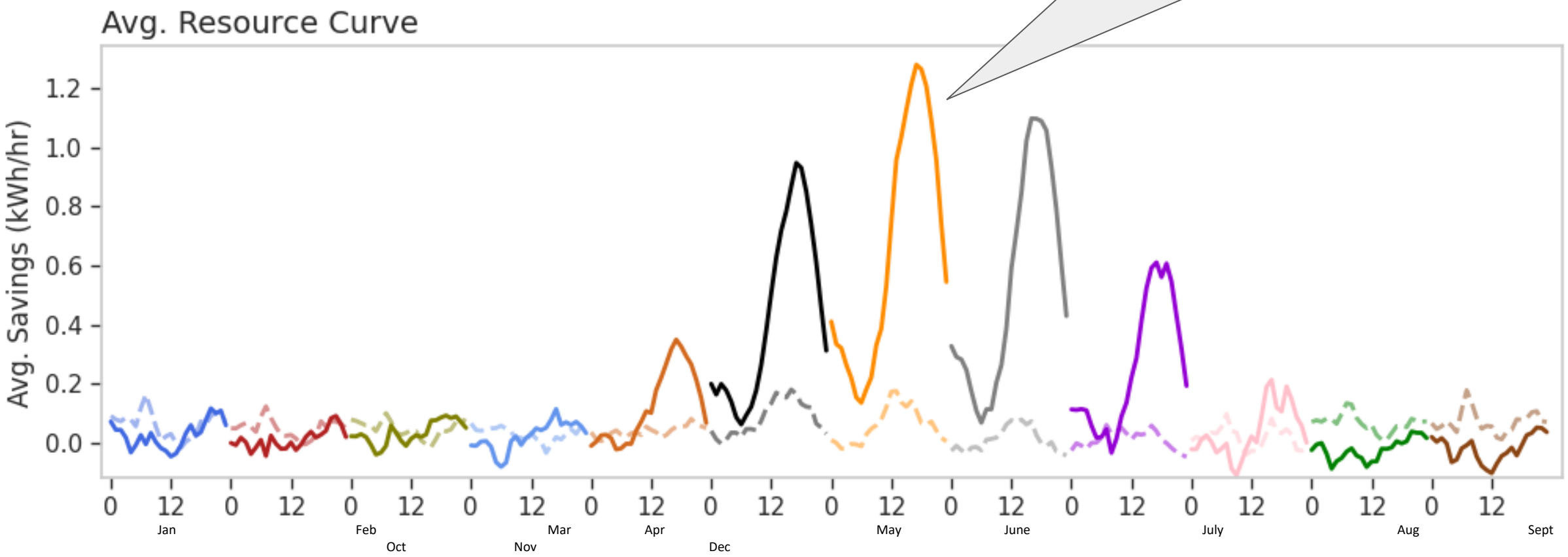
State Calculator

Targeting Increases kWh and Peak Savings

Recurve

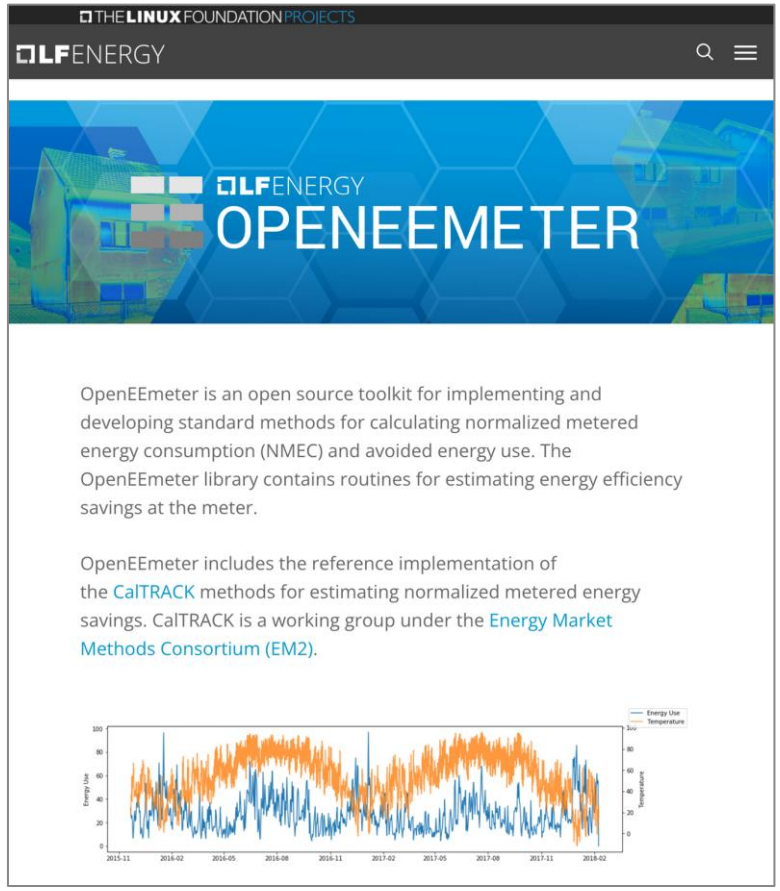
TOP 50% OF CUSTOMERS

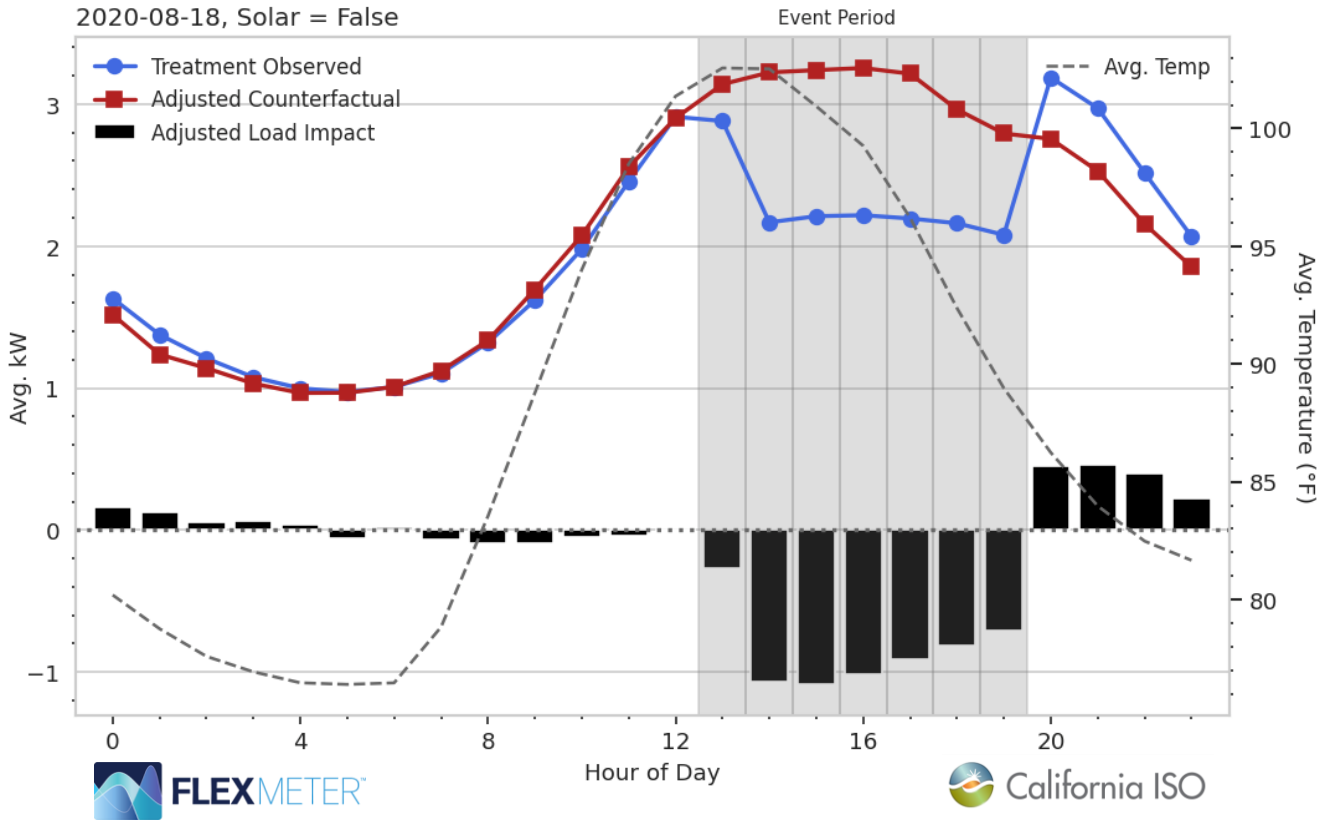
4x Summer Peak Savings



Month and Hourly Resource Curve (savings load shape)

Open-Source M&V at the Meter





Measured Performance is Simple and Low Risk

Recurve

Strategy: **Keep it simple**

- Layer on top of existing contracted programs
- Enable market access to additional aggregators

Tactics: **Rapid low risk implementation**

1. Avoids market confusion without new program designs or major changes
2. Simple for SEOs to implement with minimal overhead
3. Eliminates data and privacy issues by sharing only derivative results
4. Increase customers incentives without additional ratepayer funds


RECURVE
SHAPE THE FUTURE OF ENERGY

Home Energy Efficiency Team (HEET)

Barr Foundation

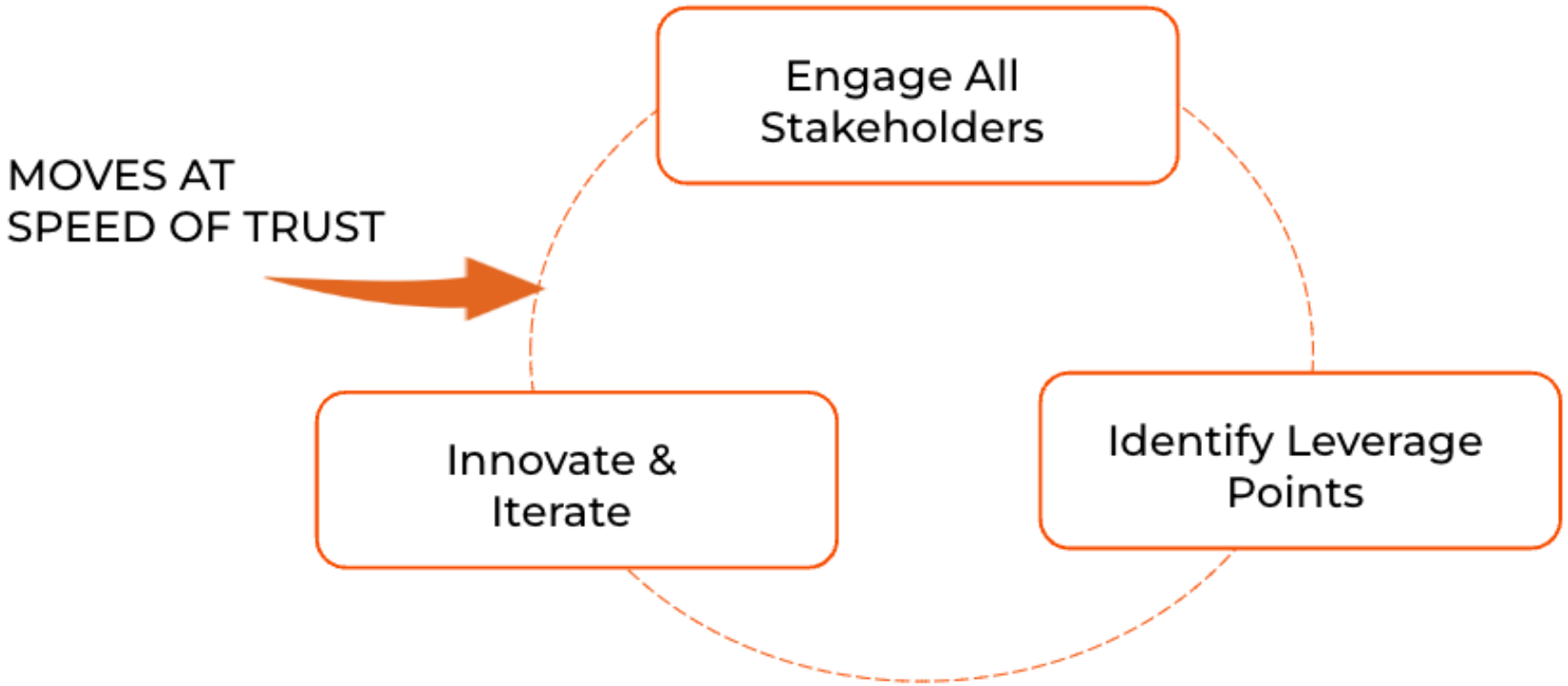
E4 THE FUTURE

Winslow Foundation

ENERGY FOUNDATION

MASSACHUSETTS CLEAN ENERGY CENTER

HEET Methods



heet

HEET Research

GEO
MICRO
DISTRICT

Feasibility Study

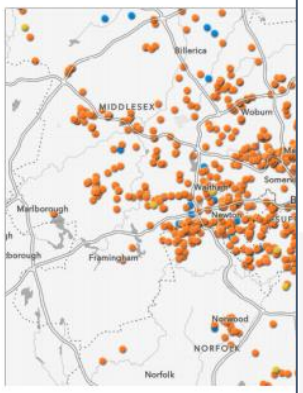
heet

Significant Environmental Impact (SEI)
Natural Gas Leaks

Shared Action Plan Year 1 (2019/2020)

Utilities Enacting the Lea

April 27th 202



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HEET 2219-1551

LEARNING FROM THE GRO

GeoMicroDistrict Pilot: Installation, Evaluation ar

Audrey Schulman, Business Manager
Zeyneb Magavi, Principal Investigator

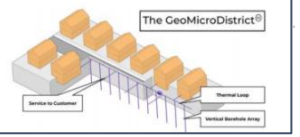
roDistrict

HEET is an award-winning Massachusetts nonprofit that c
concept and that aims to achieve two goals over the thre

1. **Evaluate the pilot GeoMicroDistrict capacity** a) meet a
demands for an approximately 100,000 sf dense, mixed-
minimize energy use and costs through optimization and
borehole thermal energy storage c) positively interact wi
resilience and reduce overall cost.

2. **Establish a standard method of GeoMicroDistrict rese**
policy makers and utilities of significant engineering and
impacts of GeoMicroDistricts. By driving down costs and
business case for utilities to install networked geotherma
transformation.

GeoMicroDistricts use bidirectional borehole thermal energy storage (BTES) as the prime source of thermal energy for buildings. A subsurface ambient temperature water loop, maintained at 40-80°F across seasons, delivers that temperature through service lines to buildings. The use of an ambient-loop



ENVIRONMENTAL Science & Technology

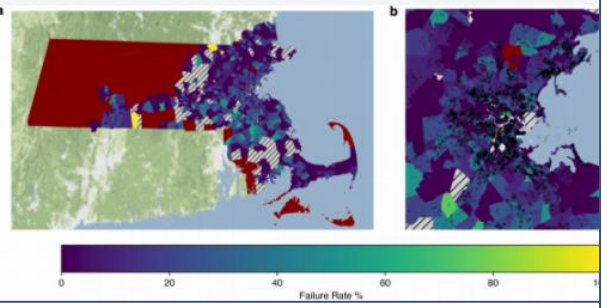
pubs.acs.org/est

Repair Failures Call for New P
Distribution Systems

Morgan R. Edwards,* Amanda Giang, Gregg
Robert Ackley, and Audrey Schulman

Cite This: https://doi.org/10.1021/acs.est.0c07531

ACCESS | Metrics & More | Article Recommendations | Supporting Inf



ELSEVIER

Energy Policy

Volume 162, March 2022, 112778

An environmental justice analysis of distribution-level natural gas leaks in Massachusetts, USA

Marcos Luna [a], Dominic Nicholas [b]

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https://doi.org/10.1016/j.enpol.2022.1

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ENVIRONMENTAL Science & Technology

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Article

Home is Where the Pipeline Ends: Characterization of Volatile Organic Compounds Present in Natural Gas at the Point of the Residential End User

Drew R. Michanowicz,*[,▽] Archana Dayalu,[▽] Curtis L. Nordgaard, Jonathan J. Buonocore, Molly W. Fairchild, Robert Ackley, Jessica E. Schiff, Abbie Liu, Nathan G. Phillips, Audrey Schulman, Zeyneb Magavi, and John D. Spengler

Cite This: https://doi.org/10.1021/acs.est.1c08298

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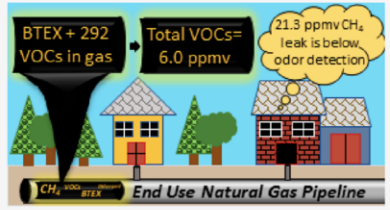
ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: The presence of volatile organic compounds (VOCs) in unprocessed natural gas (NG) is well documented; however, the degree to which VOCs are present in NG at the point of end use is largely uncharacterized. We collected 234 whole-NG samples across 69 unique residential locations across the Greater Boston metropolitan area, Massachusetts. NG samples were measured for methane (CH_4), ethane (C_2H_6), and nonmethane VOC (NMVOC) content (including tentatively identified compounds) using commercially available USEPA analytical methods. Results revealed 296 unique NMVOC constituents in end-use NG, of which 21 (or approximately 7%) were designated as hazardous air pollutants. Benzene (bootstrapped mean = 164 ppbv; SD = 16; 95% CI: 134−196) was detected in 95% of samples along with hexane (98% detection), toluene (94%), heptane (94%), and cyclohexane (89%), contributing to a mean total



NetGeo

- “Shallow” boreholes
- Ambient temperature
- Single pipe
- Infrastructure in the street
- No glycol
- Sized for stochastic load
- Thermal management
- Backup supplemental heater and chiller

heet

Regulatory Mandates

- Safety
- Security

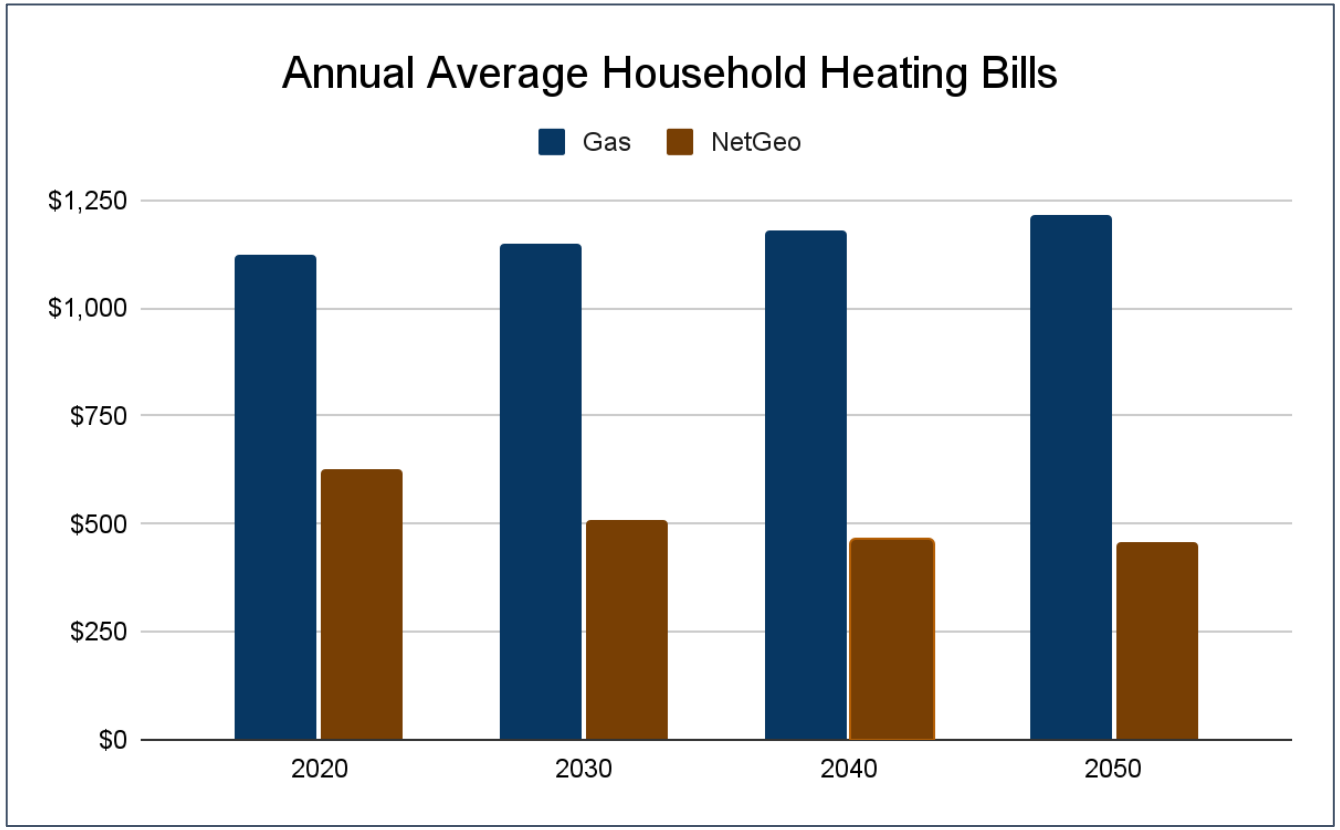
Merrimack Valley Gas Disaster 2018

heet

Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills

MA Energy Bill Projection (gas vs NetGeo)
(Applied Economics Clinic Brief)



Inflection Point; When Heating with Gas Costs More; Applied Economic Clinic Jan 2021

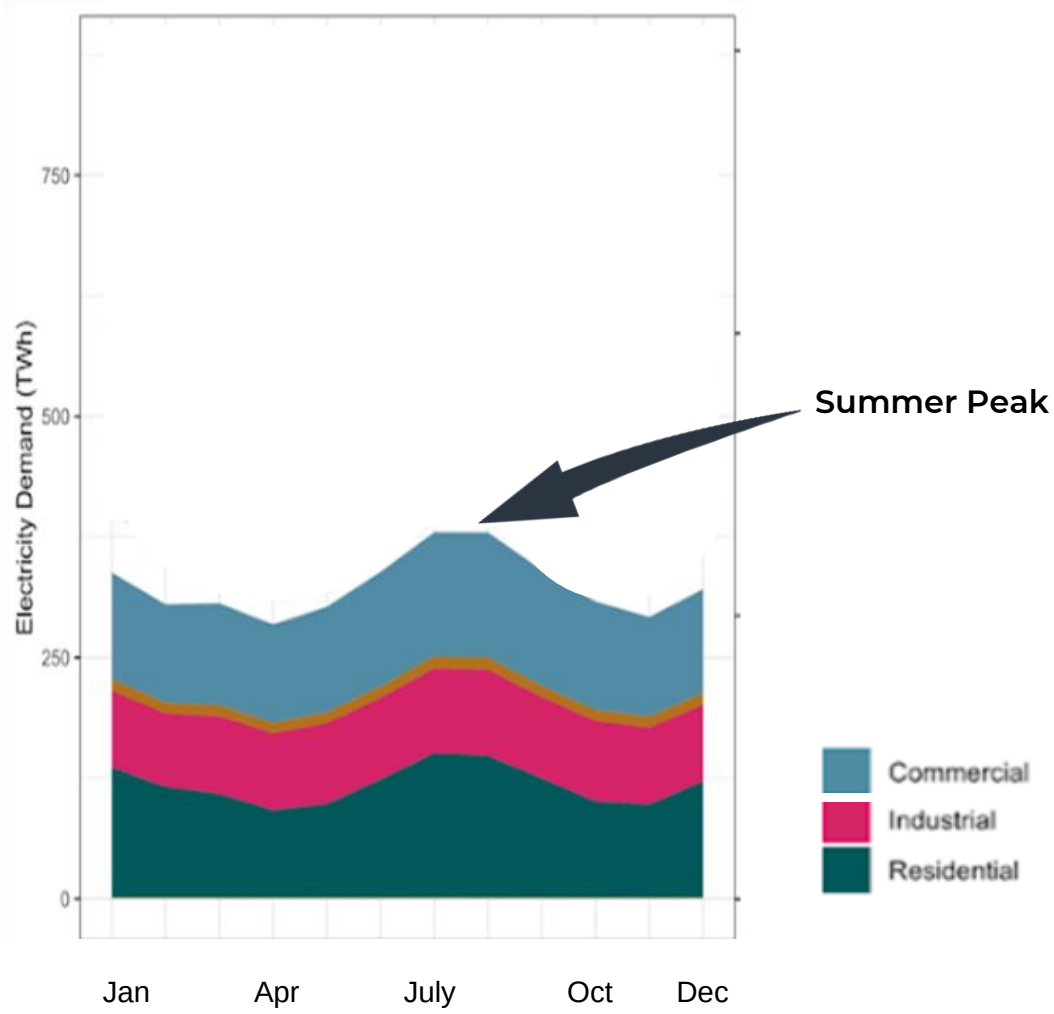
heet

Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills

Current US Seasonal Electric Peaks

(for buildings)



Buonocore, J., Salimifard, P., Magavi, Z., Allen, J., "The Falcon Curve: Implications of Seasonal Building Energy Use and Seasonal Energy Storage for Healthy Decarbonization" DOI: 10.21203/rs.3.rs-1054606/v1

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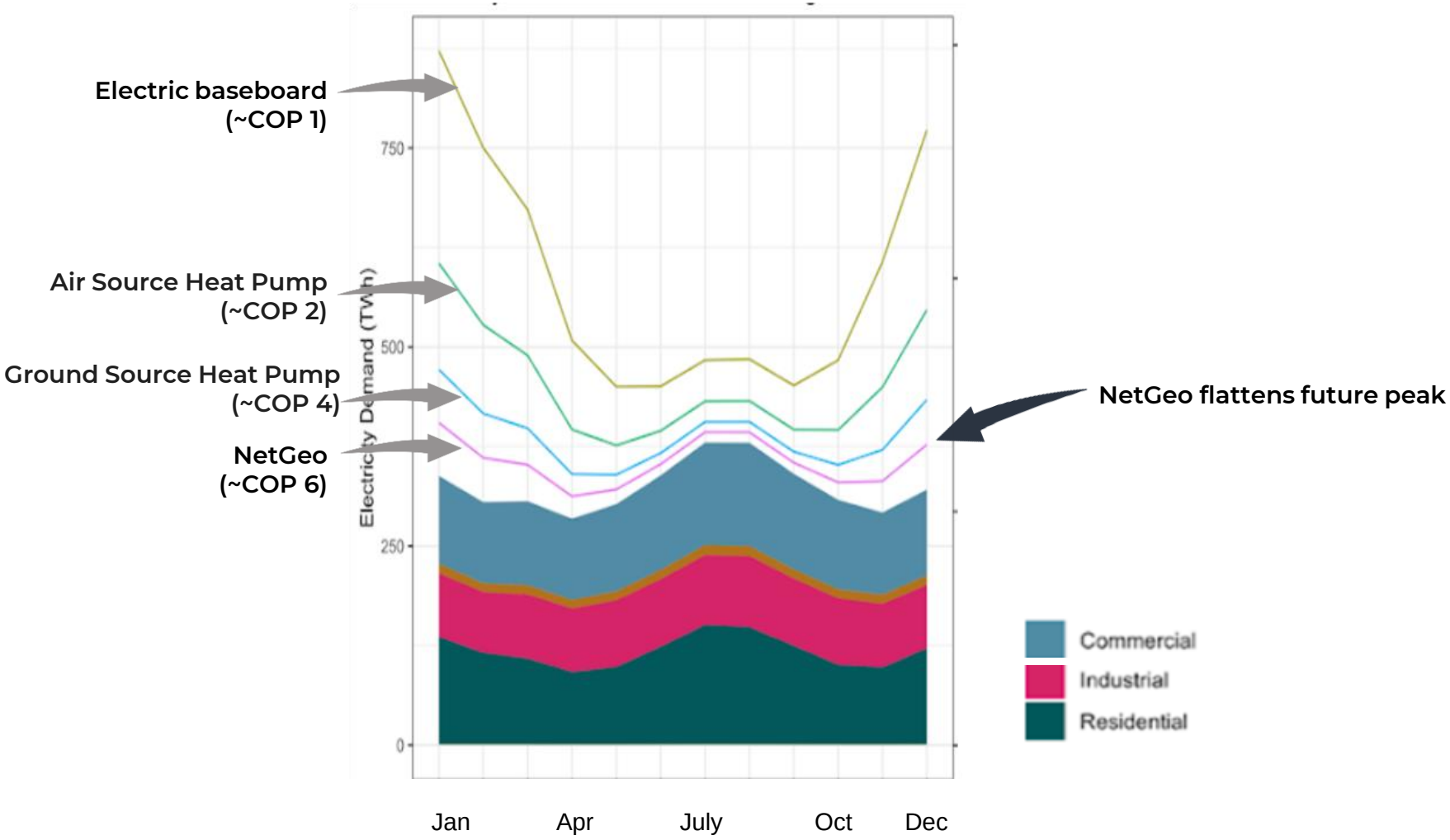
Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills

Future US Seasonal Electric Peaks

(as we electrify)



Buonocore, J., Salimifard, P., Magavi, Z., Allen, J., "The Falcon Curve: Implications of Seasonal Building Energy Use and Seasonal Energy Storage for Healthy Decarbonization" DOI: 10.21203/rs.3.rs-1054606/v1

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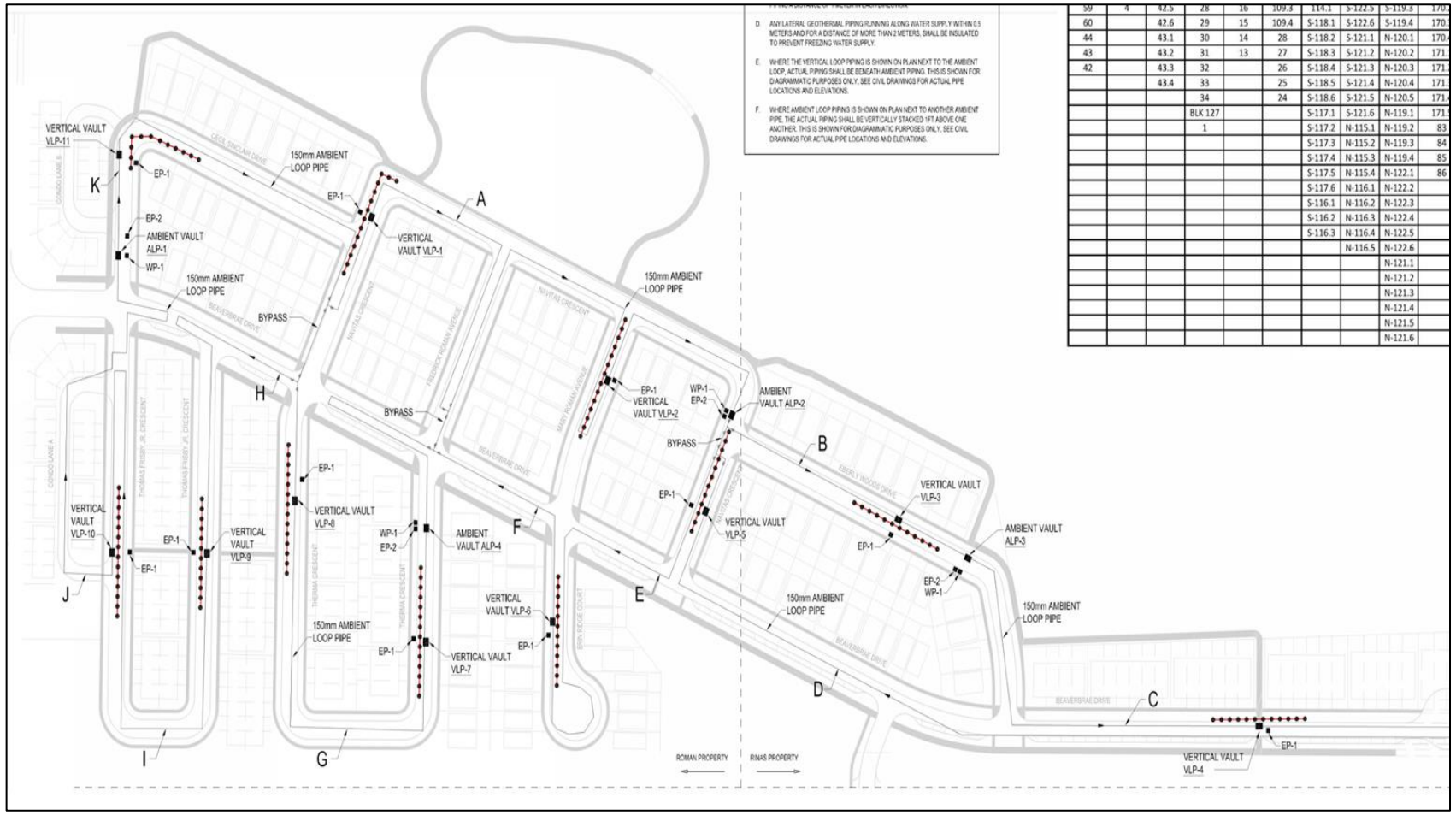
Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills
- Reliability
  - Cold climate

Toronto Berczy-Glen



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Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills
- Reliability
  - Cold climate
  - Local energy

No Single Point Failures

Business

'Perfect Storm' Caused Massive Newport Gas Outage: Report

The week-long January gas outage left thousands of Aquidneck Island residents without heat during dangerously cold temperatures.

Rachel Nunes, Patch Staff

Posted Wed, Oct 30, 2019 at 2:55 pm ET | Updated Wed, Oct 30, 2019 at 5:04 pm ET

Reply (1)

heet

Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills
- Reliability
  - Cold climate
  - Local energy

- *Equity*
  - *Customers*

heet

Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills
- Reliability
  - Cold climate
  - Local energy

- *Equity*
  - *Customers*
  - *Workforce*

Gas Pipes

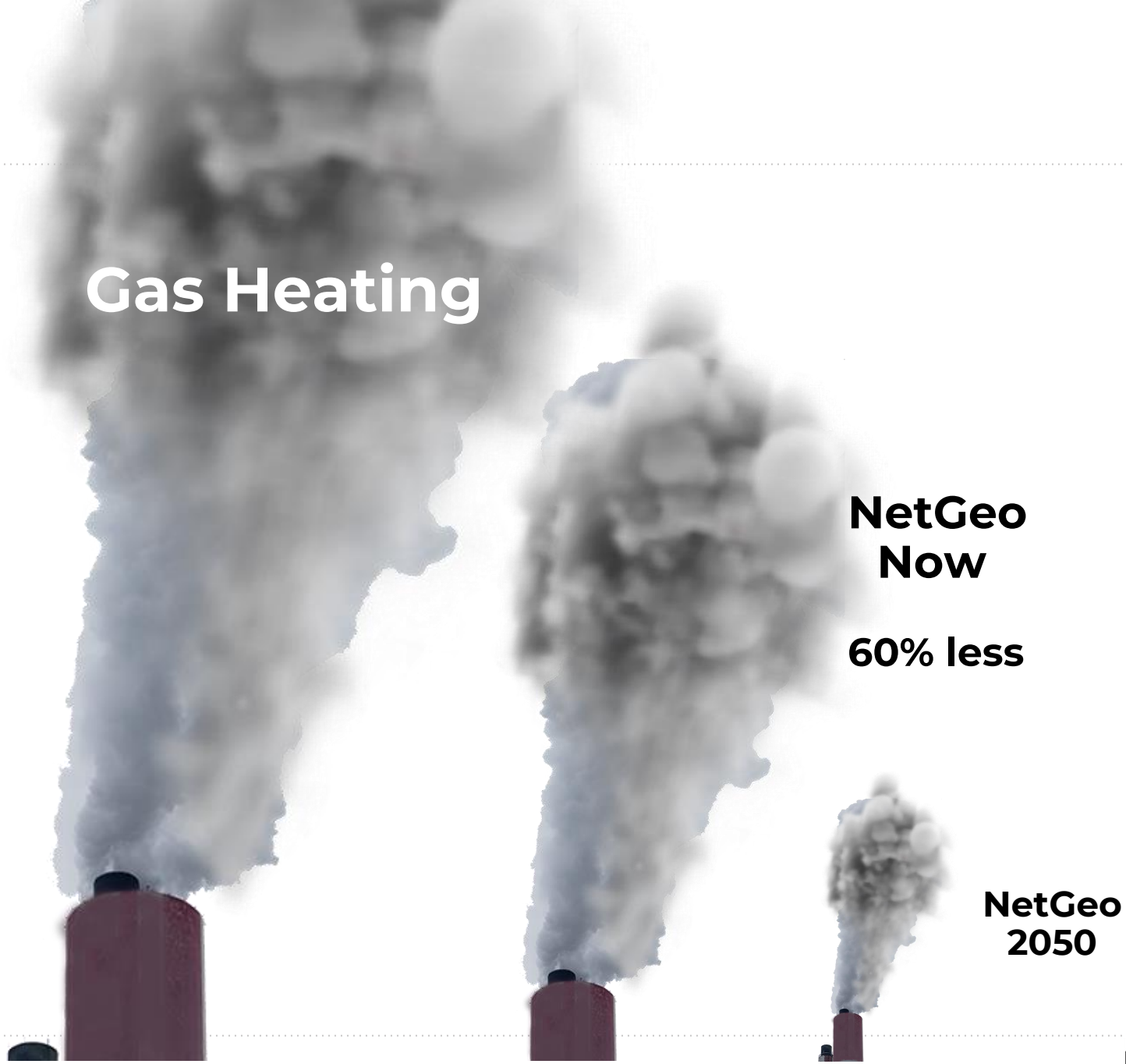
Water Pipes

heet

Regulatory Mandates

- Safety
- Security
- Affordability
  - Heating bills
  - Electric bills
- Reliability
  - Cold climate
  - Local energy

- *Equity*
  - *Customers*
  - *Workforce*
- *Emissions*



GeoMicroDistrict Feasibility Study, Buro Happold Engineering, 2019

heet

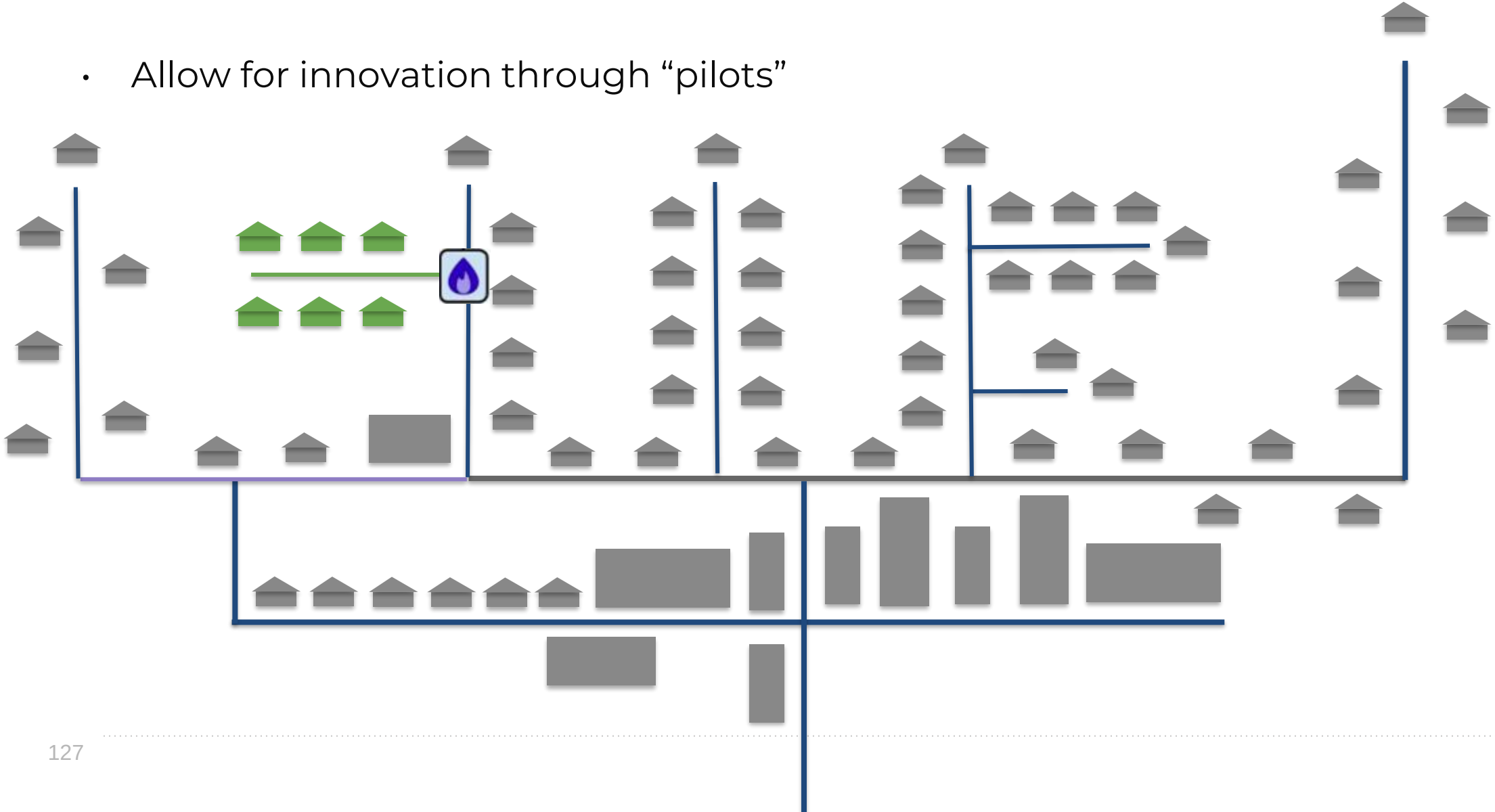
	Feasibility Studies	Approved Installation(s)	Legislation
DC	Yes	1	
Maryland			Geothermal Heating & Cooling Systems (H.1007)
Oregon	Yes		
Minnesota	Yes		Natural Gas Innovation Act (216B.2427)
New York	>40 studies	2	Utility Thermal Energy Network & Jobs Act (S.9422)
Philadelphia	Yes ($500k)		City approval
Vermont	Starting		
Massachusetts	Yes	6	Driving Clean Energy (S.2148) Energy Diversity (H. 4568)

heet

Policy Phases

Innovation

- Allow for innovation through “pilots”



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Policy Phases

Innovation

- Allow for innovation through “pilots”
- Maximize learning & trust through research

Eversource NetGeo Installation Framingham, MA

HEET Research Team

- NREL, LBNL, MIT
- Databank
- Best practices
- Optimization model

heet

Policy Phases

Innovation

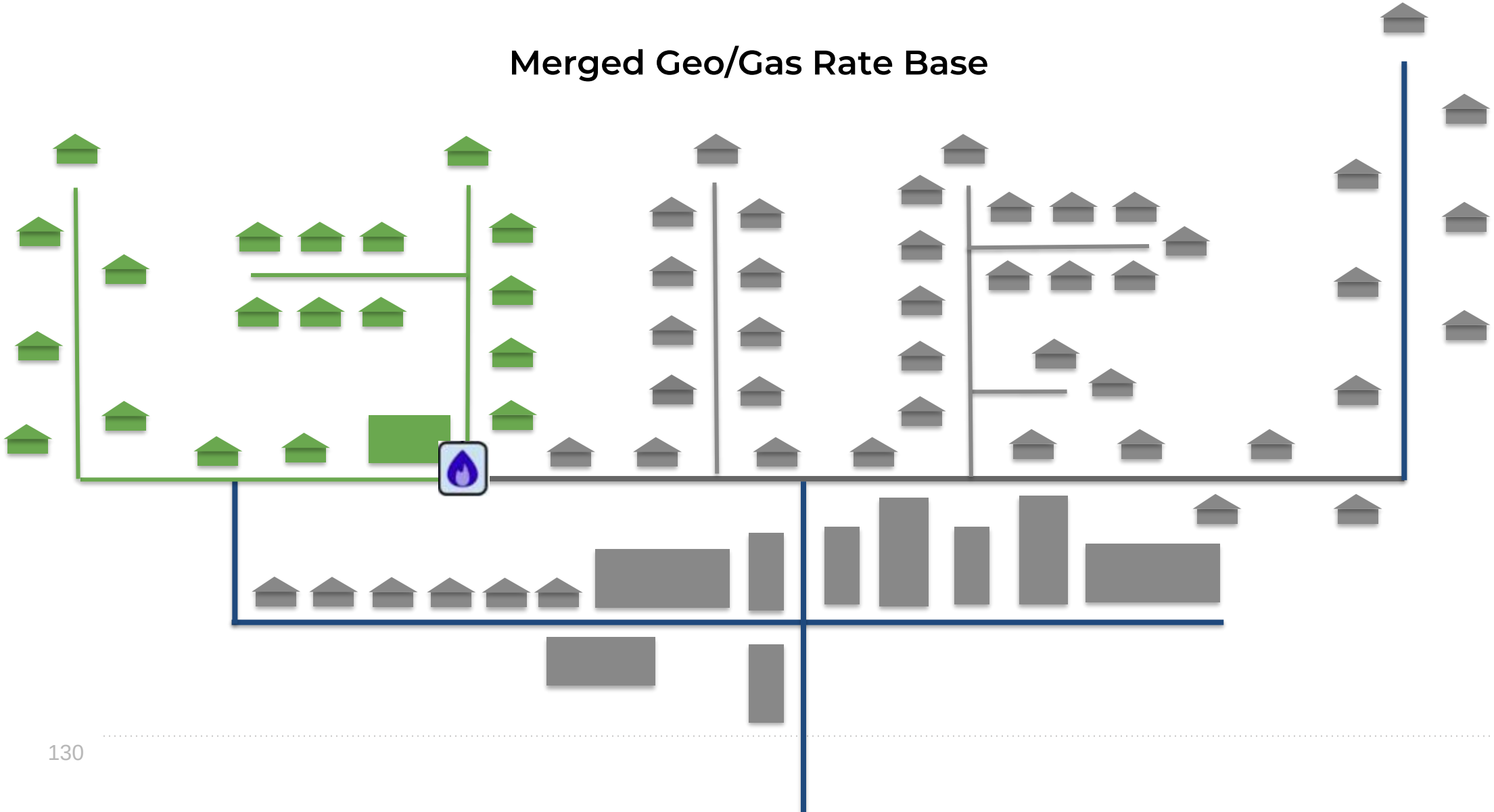
- Allow for innovation through “pilots”
- Maximize learning & trust through research
- Explore metering & billing

heet

Policy Phases

Innovation

Iteration



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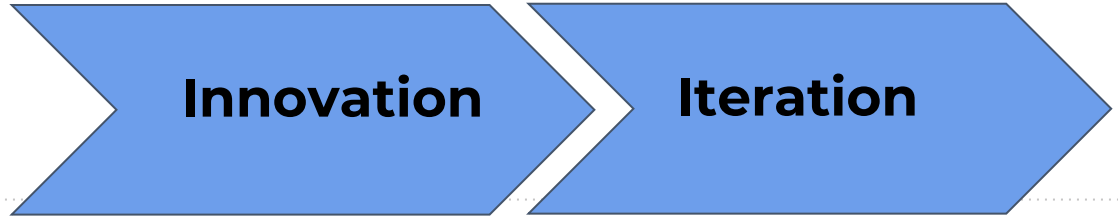
Policy Phases



- Paying for building retrofits (a few possible options)
  - State efficiency programs
  - Pay as you save on-bill financing
  - Proactive securitization
  - IRA tax credits & DOE Loan Program → Climate bank?

- Make gas & thermal service equivalent
  - Obligation to serve
- Accelerated depreciation of gas infrastructure

heet

Policy Phases

Innovation → Iteration → Maturity

heet

Reliable Secure Power Systems (RSP Systems)

CT DEEP Comprehensive Energy Strategy Technical Session 8

Market Based Decarbonization programs and low-carbon incentives

December 15, 2022

RSP Systems
AUTHORIZED CAPSTONE DISTRIBUTOR

BRENMILLER
THERMAL ENERGY STORAGE

AGENDA

Technical Overview

- Long Duration Thermal Energy Storage (TES)
- Benefits of TES
- Case Study Example

CT CES Inputs on how to Promote

Company Overview

Brenmiller- OEM https://bren-energy.com/

RSP Systems- US Distributor

Established in 2004

- Capstone Distributor for CT, NY, OH
- Microgrid solutions
- 200+ CHP installations in region
- Microgrid Solutions
- Solar/Battery
- Rental Power
- https://www.rsp-systems.com/

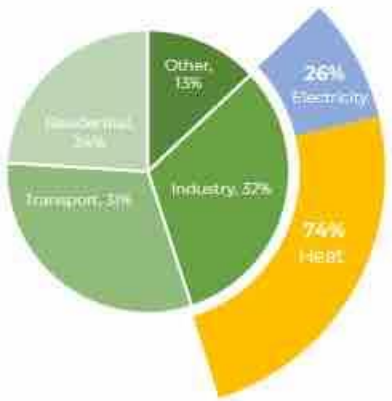
RSP Systems
AUTHORIZED CAPSTONE DISTRIBUTOR

TES can Decarbonize Heating Markets

INDUSTRIAL HEAT MARKET

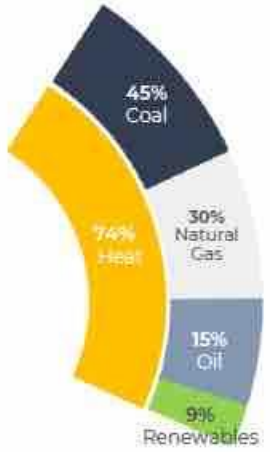
Renewable based heat is a crucial for net-zero emissions

GLOBAL ENERGY CONSUMPTION



Industrial Heat accounts for **1/4** of global energy consumption

ENERGY SOURCES FOR INDUSTRIAL HEAT



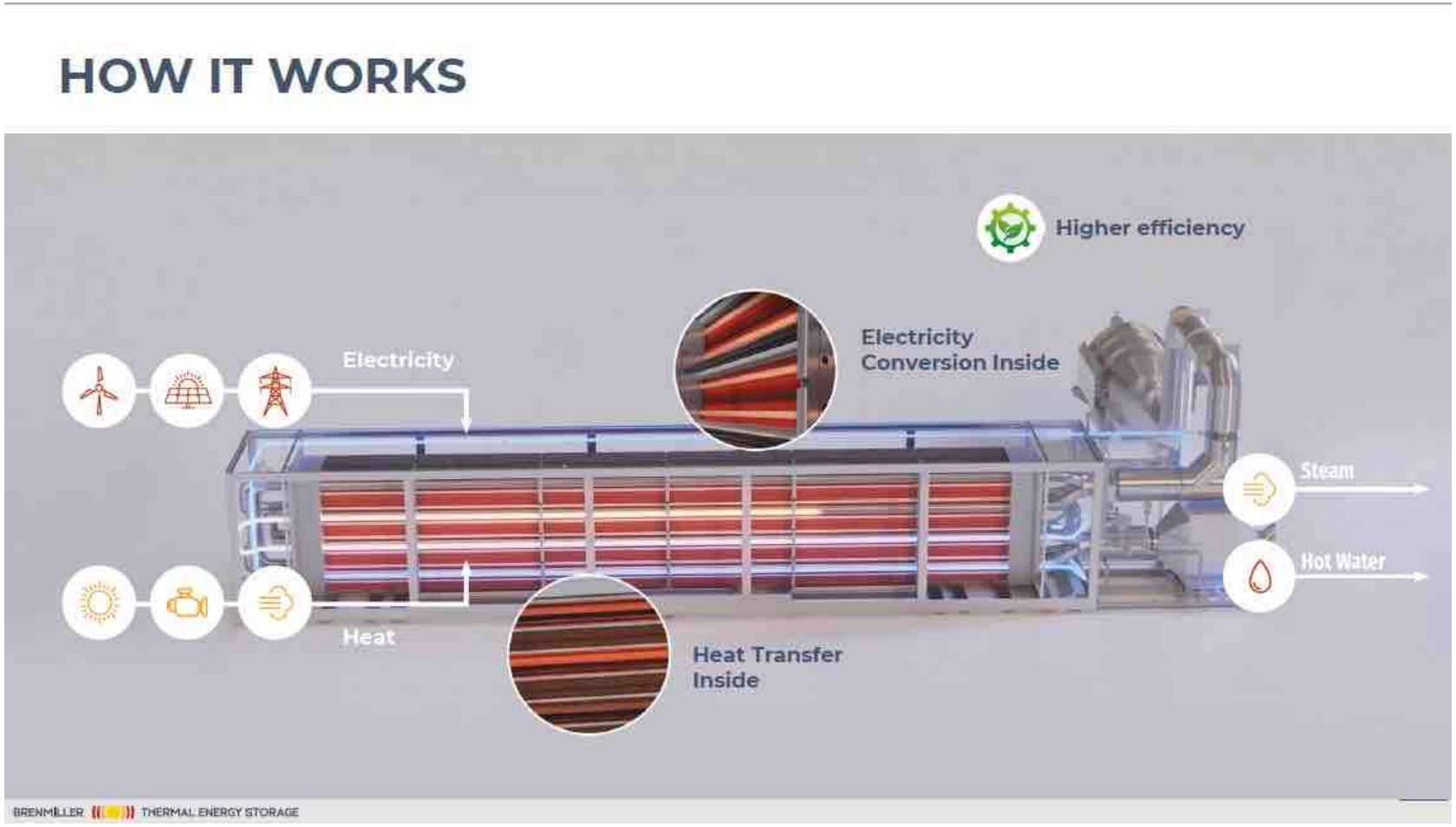
Industrial Heat is heavily based on fossil fuels

Modular Technology

Capabilities

- Can produce High Pressure steam
  - Saturated and superheated
- Can produce hot water
- Can store thermal energy from external source
- Internal heating elements to convert kWh to BTUs
- Can charge off hours
- Efficient long duration storage media
- Scalable (up to utility scale applications)
- Basic siting & permitting requirements

Long Duration Thermal Energy Storage



Local Project- SUNY Purchase

Project Overview

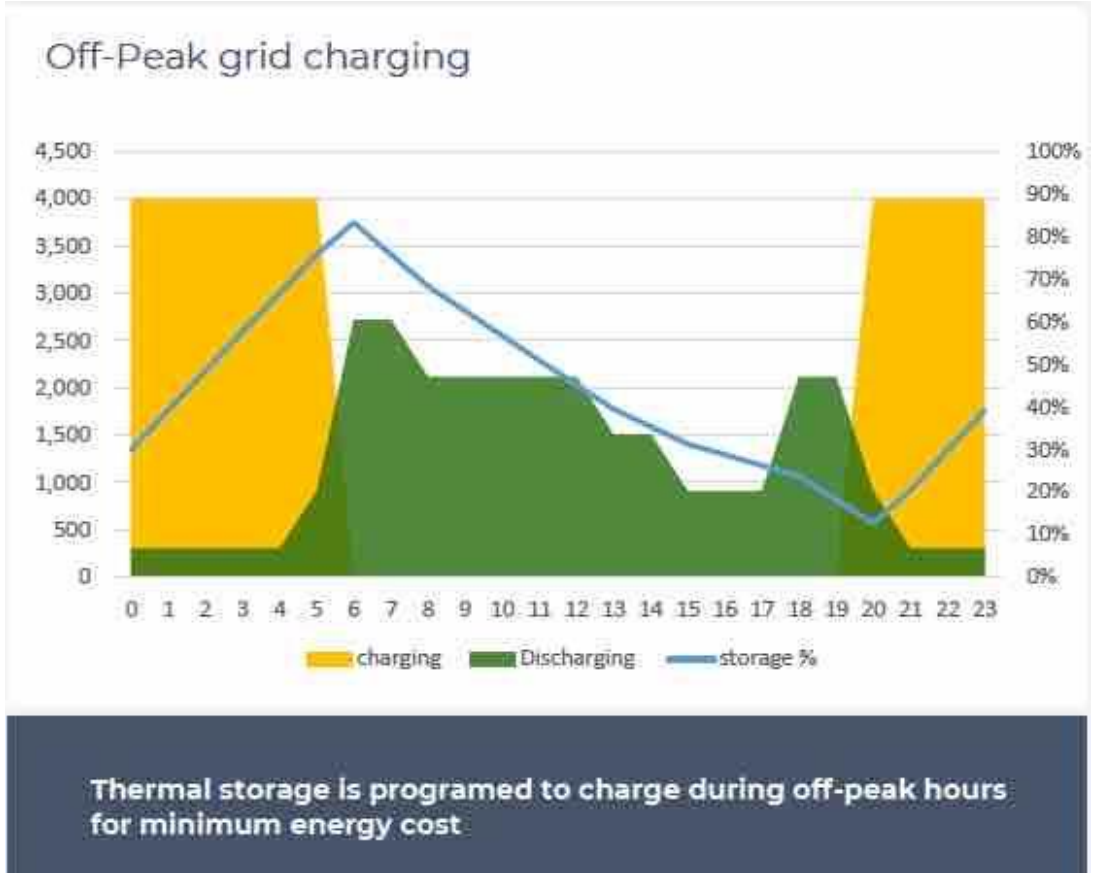
- Supports Campus Natatorium
- Energy and emissions reduction
- CHP provides power to facility
- Thermal Energy from CHP is stored in TES module for flexible time of use (pool, bldg. heat, domestic hot water)
- Internal electric heaters.
  - Can provide additional heat to cover 100% of thermal demand

How much carbon can be offset?

Average 250 bed hospital in CT

- Uses ~ 1,000,000 therms of gas annually
- Converting from traditional boilers to TES?
  - 11.7 MM # of CO_2 reduction per year

Charge during Off-peak & use on demand



Benefits of Off-Peak Charging

- Charge when kWh are cheapest
- Charge when electricity is “greenest”
- Use TES during peak hours
- Can store thermal energy for days

CT DEEP- Path toward Decarbonization

- Aggressively pursue decarbonization of industrial thermal processes
  - Technology is currently available
  - Will support State goal of 100% carbon neutral by 2040
- Siting/installation is similar to traditional boiler
- Key markets that will benefit (any facility with large thermal loads)
  - Healthcare
  - Manufacturing
  - District Energy Loops
  - Colleges and Schools
  - Food and Beverage
  - Pharma, Chemical, Paper

CES Inputs

- Expand CT's definition of Energy Storage (aka- battery storage)
  - Modify existing program to include Thermal Energy Storage (TES)
  - Up-front incentives to offset CAPEX
  - Production credits to offset OPEX (RECs, tax credits, etc.)
- Establish new Time of Day Rate for TES end-users
  - Example- model new Rate similar with existing Rate 56/58, just for TES end-users
  - Hourly matching to renewable generation to enable "clean and green" thermal output.
- Wholesale PPA between generating asset with available off-peak production
  - Wind, nuclear, solar farms
  - "Charge" the TES during off-peak hours for cleanest energy source & lowest cost kWh
- Social and Economic Benefits
  - Historically communities with prevalent industrial base are often economically disadvantages
  - Develop reasonable incentives in these regions to promote adoption

Molly Connors
Policy Analyst – Manager
New England Power Generators Association (NEPGA)

Diversified Energy Specialists

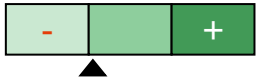
Thermal Portfolio Standards & Clean Heat Standards:
The Future Regulatory Environment of the Thermal Sector

Report Prepared For:

December 15, 2022

Thermal Energy Policy

States are considering several different policies to reduce greenhouse gas emissions from the residential, commercial and industrial thermal building sector

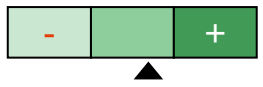
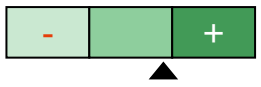
	Portfolio Standard	Fuel Standard	Rebate Program	Emissions Standard
Overview	Portfolio standards require utilities to purchase a percentage of the electricity they distribute from clean sources within the portfolio standard.	Introducing legislation to change the fuel in a state is the most attractive method to reach higher blend levels. While fuel standards may cause prices to rise slightly in the near-term, retailers will not face any negative impacts from fuel standards.	Residential rebate programs are in each New England State. They are typically funded and administered by the utilities and funded by a surcharge on every homeowner's electric bill. Mass Save is a good example of these programs trending away from fossil fuel equipment rebates.	Emissions Standards aim to gradually reduce the carbon intensity of fuels over time. If the carbon intensity of your fuel is reduced by less than the obligation that year, you must purchase credits. If you reduce your carbon intensity by more than the obligation, you will generate credits.
Commentary	• Portfolio standards have been successful in the electricity sector. • Thermal sector portfolio standards have been the most successful in states that incentivize alternative fuels at the retailer level	• With three states having fuel standards enacted, other states have definitive case studies to refer to when introducing legislation for their own mandates. • Fuel standards directly impact ghg emissions in a state and are the more effective way to reduce emissions.	• While these programs typically funded all heating equipment for homeowners within the state, several programs have considered removing fossil fuel equipment rebates. • These programs are following the “electrify everything” narrative and moving towards electric heating equipment rebates exclusively.	• The obligated parties can be the prime supplier, wholesalers, or the first point of sale within a state. • Eligible technologies can generate credits within an Emissions Standard.
Examples	• MA APS • ME Thermal RPS Class III • PA AEPS Class II (Considering)	• Rhode Island • New York • Connecticut • Massachusetts (not enforced)	• Mass Save • Energize CT • Efficiency VT	• CA LCFS • VT CHS (Veto 5/2022) • MA CHS (Considering) • ME CHS (Considering) • NY CHS (Considering)
Impact				

Source: Diversified Energy Specialists Research & Analysis

DIVERSIFIED ENERGY SPECIALISTS

Thermal Energy Policy

States are considering several different policies to reduce greenhouse gas emissions from the residential, commercial and industrial thermal building sector

	Building Sector Standard	Cap-and-Trade Program	Carbon Tax	Fossil Fuel Ban
Overview	Building standards set gradual emission reduction goals for different types of buildings, typically buildings over 20,000 square feet. These buildings must reduce their carbon footprint vs. a baseline year to help the state meet its goals.	These programs typically begin with an auction or allowance and aims to reduce the numbers of gallons sold per year. Typically, the compliance obligation is placed at the wholesale level and wholesalers are required to purchase allowances for the carbon emissions that they will sell each year.	A carbon tax would tax the sale of fossil fuels based on each fuels carbon intensity. Typically, electricity is not included in a carbon tax and pipeline methane leaks are not included either. This type of policy would not be ideal.	Many individual cities have proposed a ban on fossil fuel systems in new-build construction. Additionally, many cities and states would like to ban the use of fossil fuels, but don't have the support to do so.
Commentary	• There are far more options for buildings to meet compliance compared to an emissions standards. Typically, carbon offsets are an option. • These standards typically apply to a certain type of building or certain size of building. • Statewide building standards have yet to be enacted.	• Given the declining cap on emissions, this program reduces the number of gallons sold from the fossil fuel industry each year. • There is an aftermarket to trade allowances. • These programs are a way to enact a carbon tax, without explicitly calling it a carbon tax.	• Many carbon tax bills have been proposed in northeast states over the past two years, but all have failed. • Voters do not view this pathway favorably.	• Cities in Massachusetts' like Burlington and Cambridge have attempted to ban the use of fossil fuels in new-build construction. These efforts have failed, but it is likely that we will see this in many other cities soon. • 10 City pilot program in MA. • Not viewed favorably by voters.
Examples	• Boston BERDO (rulemaking) • Cambridge, MA (rulemaking) • New York	• RGGI • CA Cap-and-Trade • MA Cap-and-Trade (considering)	• Washington D.C. • Washington	• Burlington, MA (failed) • Cambridge, MA (failed)
Impact				

Source: Diversified Energy Specialists Research & Analysis

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Portfolio Standard

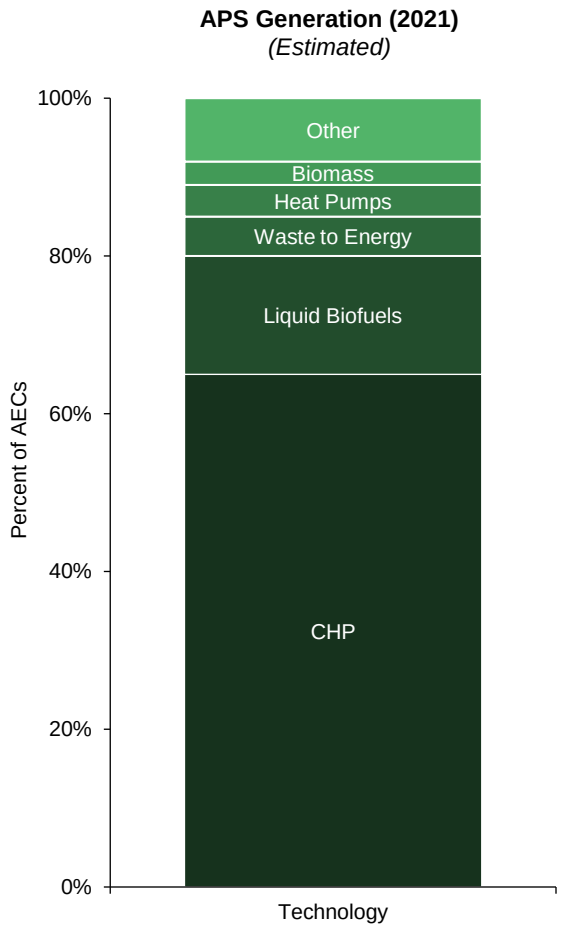
The Massachusetts Alternative Portfolio Standard is one example of a thermal incentive program that would be beneficial to Connecticut

Characteristics	Summary
Obligated Entities	Electric utilities / load serving entities delivering electricity to the state.
Compliance Obligation	Electric Utilities must purchase a percentage of the MWh they deliver to end-users in the state. In 2022, obligated parties must purchase 5.5% of the MWh they deliver to Massachusetts.
Compliance Mechanisms	Purchasing Alternative Energy Certificates or Paying the Alternative Compliance Payment ($24.74 in 2022).
Tradeable Credit	Yes. Eligible technologies will generate Alternative Energy Certificates that can be sold in the market.
Carbon Intensity	Any eligible technology must reduce greenhouse gas emissions by 50% or more vs. the alternative.
Eligible Technologies	Biofuels, combined heat and power, solar thermal, ASHP, GSHP, biomass, biogas, fuel cell, waste-to-energy, geothermal. All generating technologies are at the facility / end user level except for biofuels, which are incentivized at the retail level.
GHG Reporting	Reporting for all technologies occurs on a quarterly basis. Biofuels, the only exception, reports on a biannual basis.
GHG Opportunity	These programs are opt-in incentive-based programs. Historically, they have reduced greenhouse gas emissions across the state and have been an effective and cost-efficient way to reduce emissions without providing mandates or a carbon tax.

Source: Diversified Energy Specialists Research & Analysis

APS Eligible Technologies

Combined heat and power plants have historically dominated the generation in the APS



Liquid Biofuels	Solar Thermal	Heat Pumps (Air & Ground Source)	Woody Biomass
Biogas	Deep Geothermal Heat Exchange	Compost Heat Exchange	Combined Heat & Power (CHP)
Flywheel Storage Unit	Fuel Cell	Thermal Waste-to-Energy	

Source: Diversified Energy Specialists Research & Analysis

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Emissions Standard Summary

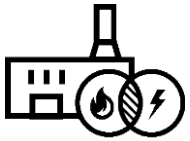
Vermont and Massachusetts could both enact a Clean Heat Standard in the next year, while other northeast states consider similar programs for the thermal sector

Characteristics	Summary
Summary	Emissions Standards provide value & incentive to emissions reduction, while not limiting or guaranteeing a decrease in emissions. However, the failure to reduce emissions will be costly.
Obligated Entities	Fossil Fuel wholesalers or the first point of sale within the state for consumption. (Natural Gas Utilities, Propane, Kerosene, heating oil, and coal).
Compliance Obligation	"Annual requirements shall be expressed as a percent of each obligated party's contribution to the thermal sector's lifecycle CO2e emissions in the previous year with the annual percentages being the same for all parties." 26% below 2001 levels by 2025, 40% below 1990 levels by 2030, and 80% below 1990 levels by 2050. 1/3 of compliance must come from low-income residences.
Compliance Mechanisms	Direct delivery of eligible clean heat measures, the market purchase of clean heat credits, or payment to a statewide appointed default delivery agent.
Tradeable Credit	Yes. Eligible technologies will generate Clean Heat Credits, which can be used to meet compliance, can be banked for an unlimited number of years, or can be sold in the market to an obligated party. 'Early Action Credits' can be generated from 2022-2024 and used for compliance in 2025.
Carbon Intensity	Carbon intensity of fuels will be measured by the GREET model.
Eligible Technologies	Weatherization, sustainably sourced biofuels, RNG and advanced gasses, the installation of cold-climate air-source heat pumps and wood heating appliances, weatherization, and solar thermal.
GHG Reporting	Typically reported through a third party annually, along with proof of retired Clean Heat Credits.
Baseline	The baseline year would be the year prior to implementation.
GHG Opportunity	These programs provide an opportunity for the market to reduce GHG emissions in a technology neutral manner that will value each metric ton of CO2e reduced equally.

Source: Diversified Energy Specialists Research & Analysis

Eligible Generating Technologies

The technologies listed have been proposed as eligible technologies in the Clean Heat Standard, with some technologies (in green) listed as potential technologies

					
Air-source Heat Pumps	**Geothermal Heat Pumps**	**Weatherization**	**Energy Efficiency**	**Solar Thermal**	**Clean District Energy** (CHP w/ renewables)
					
Demand-Side Efficiency (thermostat control during peak)	**Wood Pellets**	**Biodiesel**	**Renewable Diesel**	**Renewable Natural Gas**	**Clean Hydrogen**

Source: Diversified Energy Specialists Research & Analysis

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Recommendations for Connecticut

Study the potential impacts of regulatory programs in the transportation and heating sector to ultimately decide the most cost-efficient way to reduce greenhouse gas emissions

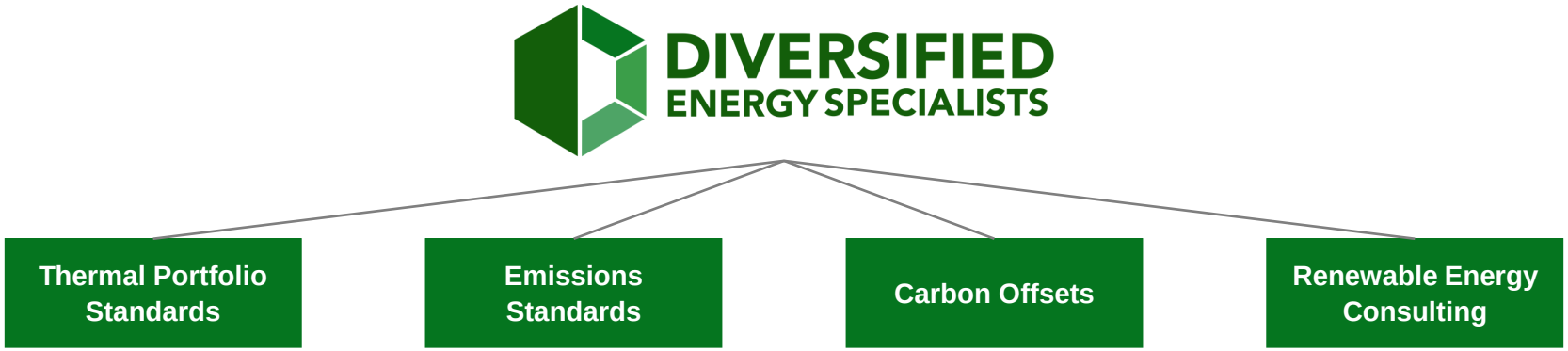
Thermal Portfolio Standard

Emissions Standard

LCFS / TCI
(including heating fuels)

Source: Diversified Energy Specialists Research & Analysis

Background & Contact Information



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- ✓ Carbon offsets
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    - ✓ Procurement
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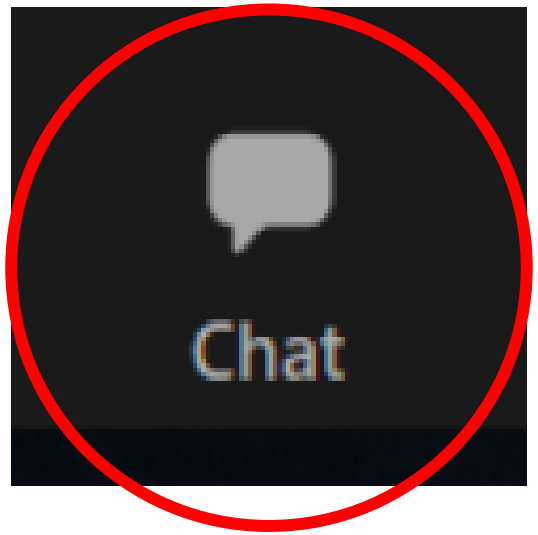
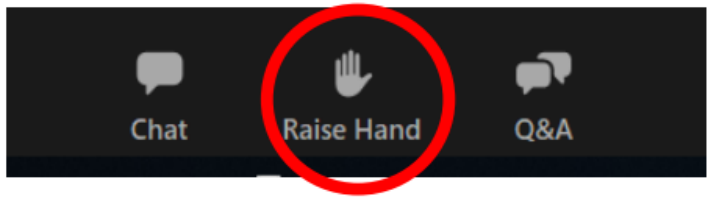
Questions

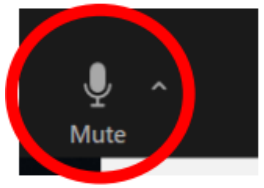


At the conclusion of each panel DEEP will hold a brief question and answer period.

If you have a question for a presenter, please drop it into the chat to **Jeff Howard**. DEEP will pose as many questions as time allows to the speakers. Clarifying questions will be prioritized. Leading questions will not be accepted.

Public Comments





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If you would like to make a comment during the public comment periods:

- Please use the “Raise Hand” feature if you would like to speak
- After any interested elected officials have provided their comments, you will be invited to provide your comment in the order the hands were raised
- Please unmute yourself, state your name and affiliation
- Given time limitations, please limit your comment to 2 minutes.
- After your comments, please remember to click the “Mute” button

General Public Comment

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WRAP UP

Thanks for joining our technical session today!

Written comments related to this session (notice), or the general Comprehensive Energy Strategy can be submitted to:

1. BETP's Energy Filings web page – or –
2. Via email to DEEP.EnergyBureau@ct.gov

All information on upcoming Comprehensive Energy Strategy technical sessions and written comment opportunities can be found on the CES webpage.

This slide deck and a recording of this session will be posted on the CES webpage

Written Comments related to this technical session will be due
Friday, January 6, 2023, at 5:00 p.m. ET

Thank you for joining!

Questions? DEEP.EnergyBureau@ct.gov

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