Trends in Low-Carbon Fuel Policies and RNG Supply/Use in the U.S.

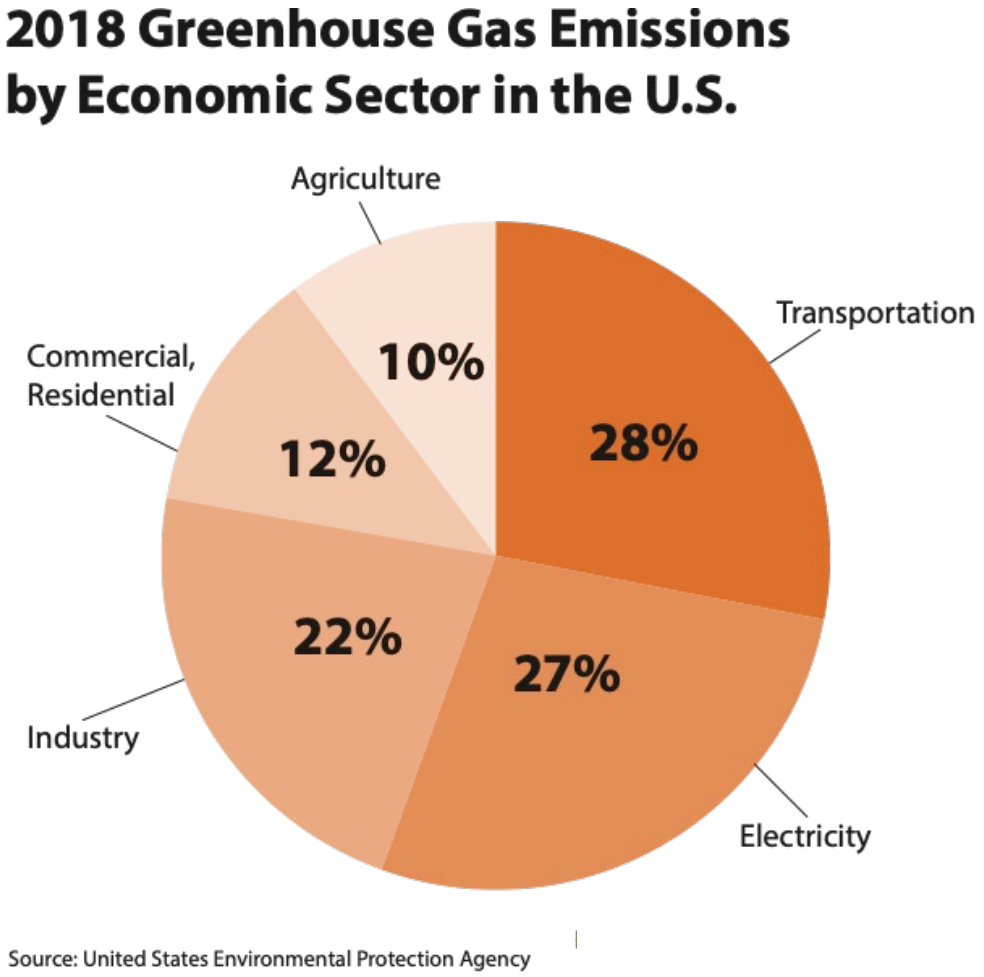
AQPER Symposium
Quebec City
May 24, 2022

Presenter: Shashi Menon, CEO, EcoEngineers

ecoengineers
people-driven solutions

How Do We Transition to a Sustainable Economy?

- 5.2 billion metric tons of CO_{2e} (Total U.S. Emissions 2020)
- Other environmental impacts
- The North Star to set baseline values and objectives
- Discourse should be inclusive of natural gas and petroleum industries



ecoengineers
people-driven solutions

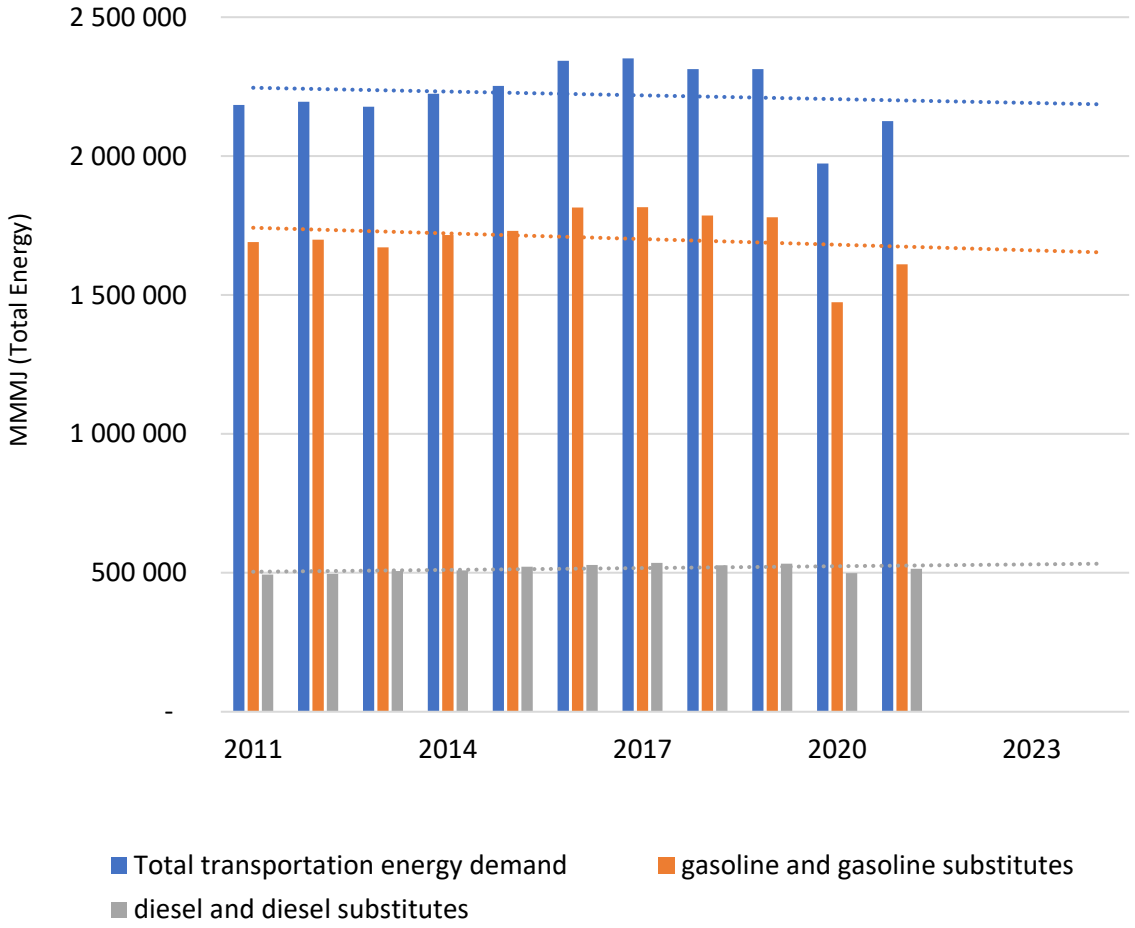
Science and Policy Need to be Complementary

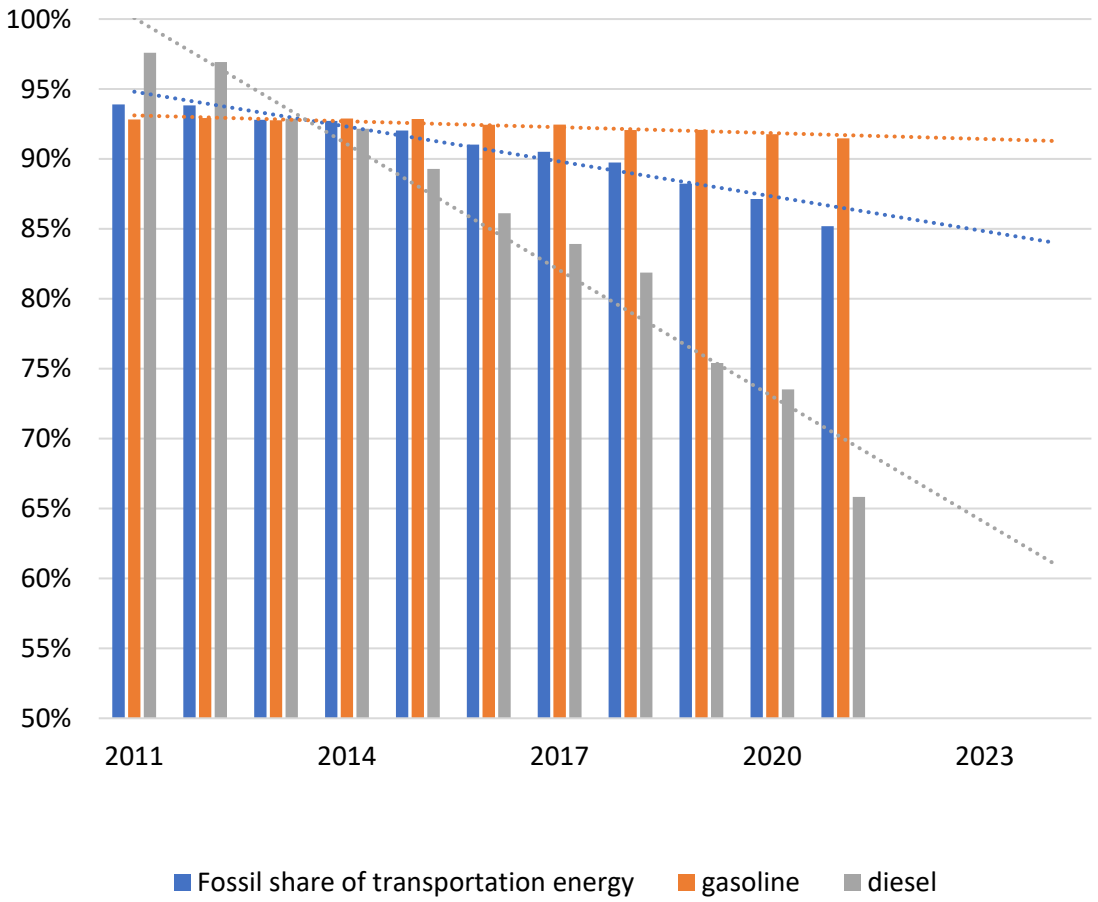
KEYS TO SUCCESS

- Ambitious carbon policies
- Technology transformations
- Effective carbon markets that trade net reductions
  - Fuel neutral
  - Science based
  - Carbon accounting for additionality and leakage
  - Strong MRV platforms based on life-cycle analysis (LCA)
- Need to standardize clean fuel incentives

ecoengineers
people-driven solutions

Fossil Share of Transportation Energy Use in California is Declining



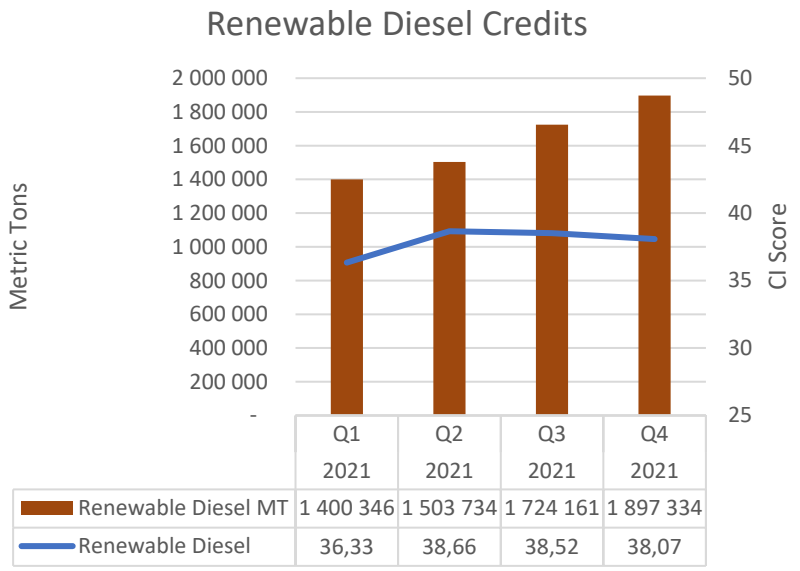


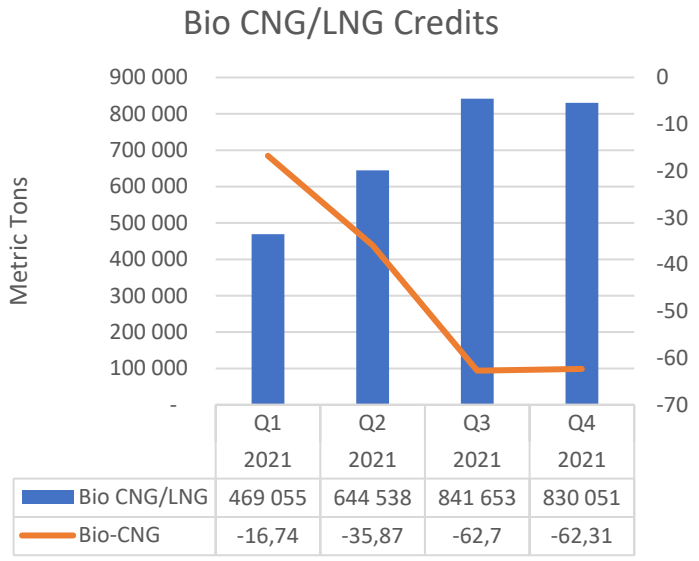
Source: EcoEngineers

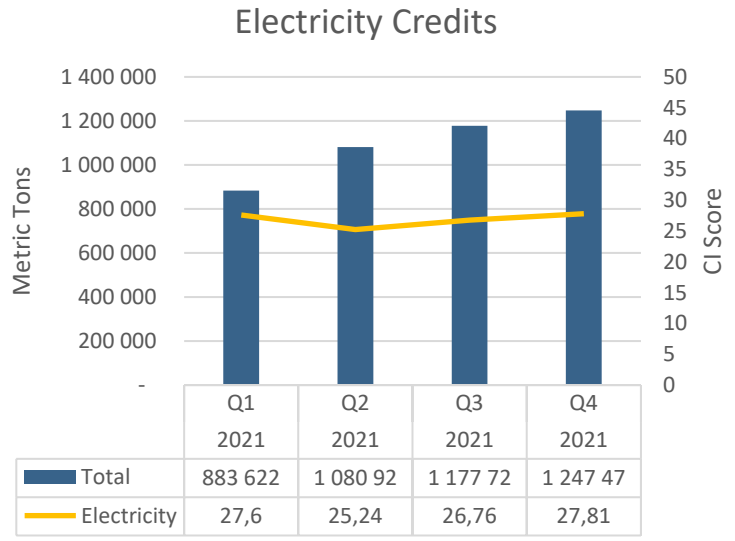
ecoengineers
people-driven solutions

Technology Transformations: RD, RNG, EV, and Hydrogen

- **Renewable Diesel**: Refineries are adapting to RD production and processing vegetable oils
- **Renewable Natural Gas**: Ultralow CI from dairy/swine manure methane offset projects
- **EV and Hydrogen:** Have captured public imagination, and secured additional policy support





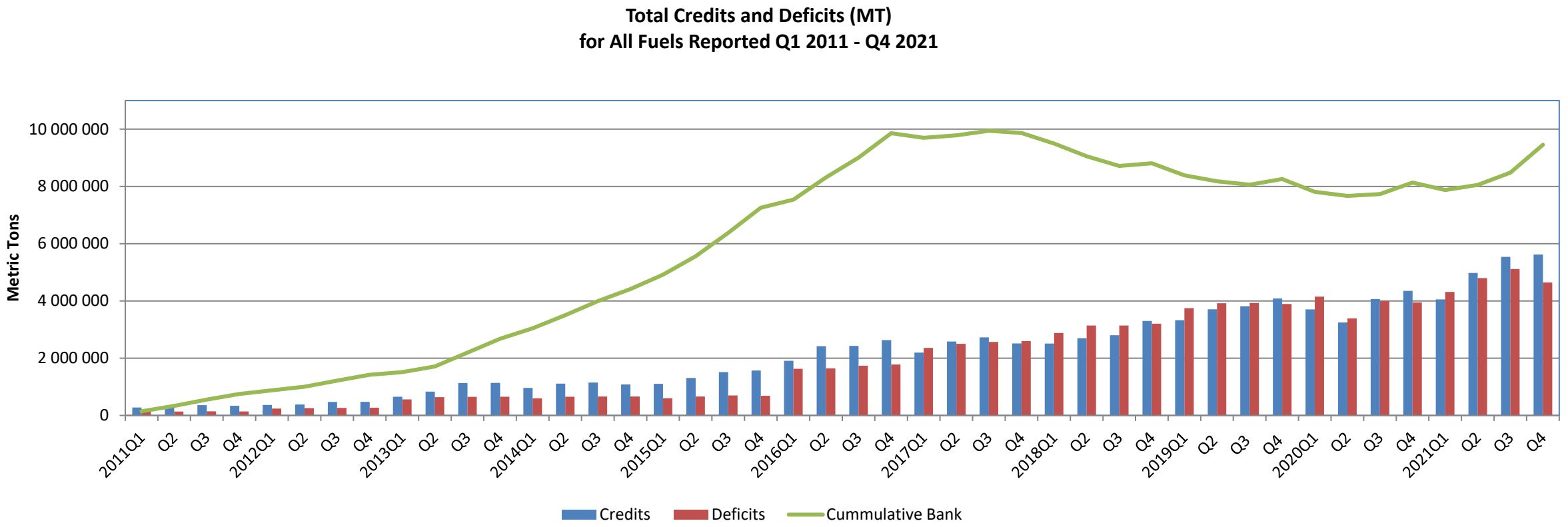


Source: EcoEngineers

ecoengineers
people-driven solutions

The Credit Bank is an Indicator of Policy Effectiveness

Finance flows are mostly aligned with carbon reduction



Source: EcoEngineers

ecoengineers
people-driven solutions

Finance Flows Are Not Always Aligned With Carbon Reduction

Program	Are Finance Flows Aligned with Carbon Reduction?
LCFS	Most aligned: Transportation focus – mostly fuel neutral – uses LCA for pathway evaluation – rewards lower CI
Voluntary Carbon Markets	Trying to be aligned: Broad focus – LCA for pathway evaluation have varying methodologies – no regulatory oversight of registries and ESG goals
RFS/RINs	Not aligned: Mandates volumetric blends of specific fuel types – no individual pathway LCA evaluation – not fuel neutral
Tax Credits	Not aligned: Investments, production, use of certain fuel types – no pathway LCA evaluation
Federal/State Grants	Not aligned: Typically, no pathway LCA evaluation for project selection
ESG Goals	Not aligned: Typically, no pathway LCA evaluation for fuel switching

ecoengineers
people-driven solutions

RNG is a Decarbonization Strategy

- Regulations and ESG goals are driving demand
- Green goals vs. carbon reductions
  - Volume based vs. carbon intensity based

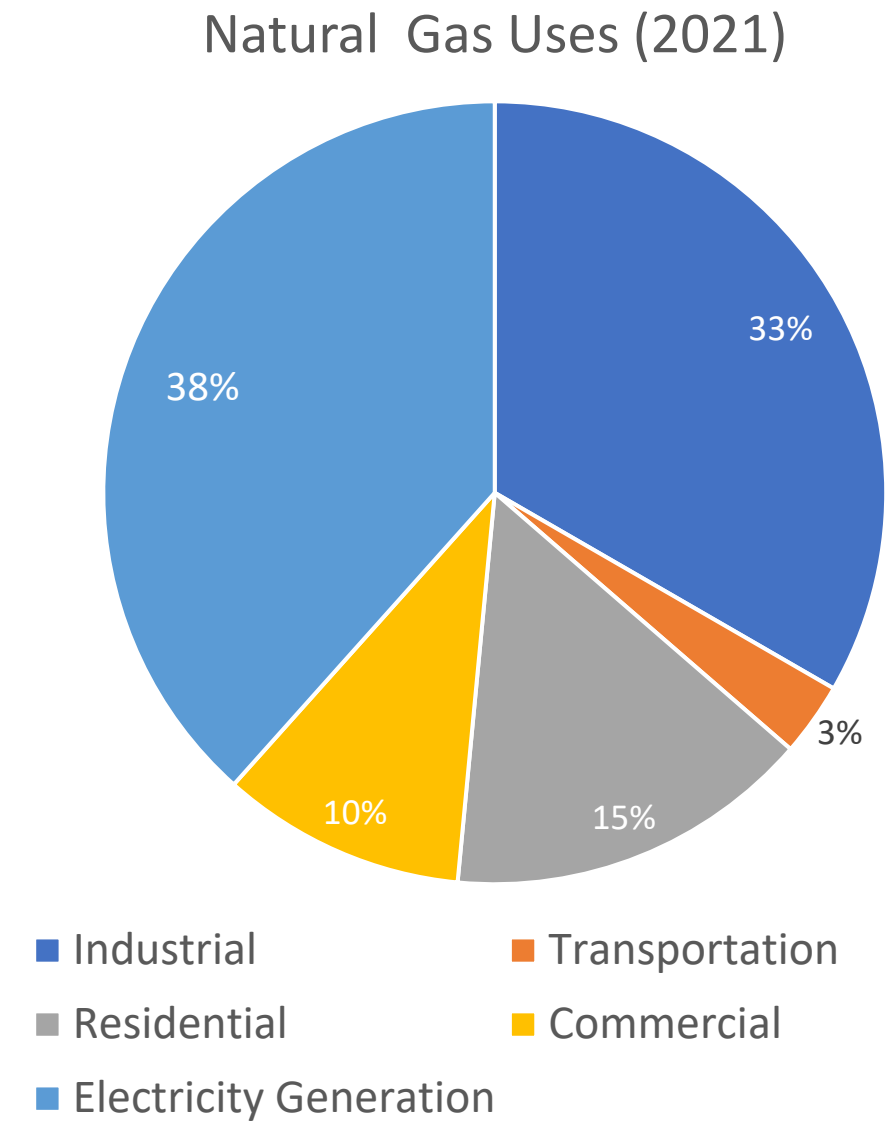
Participation options

- Buy RNG from projects
- Invest/develop own projects

ecoengineers
people-driven solutions

Small But Important …

- Total U.S. natural gas use was 32 QBtu
  - RNG RIN generation in 2021:
    - 48.5 million MMBtu
    - ~46% sold in California
    - 100% transportation markets
    - < 1% of U.S. natural gas use
    - Additional small amount for non-transportation use
  - RSG could also have impact at scale



ecoengineers
people-driven solutions

Natural Gas Price Volatility

Source: NASDAQ

ecoengineers
people-driven solutions

Avoided Emissions are Driving RNG Values

- Feedstocks with avoided methane emissions credits in California
  - Dairy
  - Swine
  - Landfill-diverted organics
- RNG is a tool to reduce emissions in agriculture and waste management
- Frees up RD for jet fuel

Value of Dairy RNG (D3 + LCFS)		
Value of Gas	$3 - $7	5%
Value of Federal Credits (D3 RINs)	$40.00	44%
Value of California Credits (LCFS) CI -273	$46.00	51%
Total	**$91.00**	**100%**

ecoengineers
people-driven solutions

RNG CI Scores and Market Values ($/MMBtu)

Assumptions: $120/MT LCFS; $2 D5; $3 D3; $15-$35 voluntary; tax credits & grants not included

RNG Type and CI	~ LCFS Value	~ RIN Value (D3 or D5)	~ Voluntary Market Value	Carbon reduction MT/MMBtu	Implied CO_2e Price ($/MT)
Landfills: 30 to 60	$6	$35	$15	0.05	$300 - $800
WWTPs: 20 to 50	$7	$23 - $35	$15	0.06	$250 - $650
Dairy/Swine manure: -100 to -300	$37	$35	$35	0.31	$100 - $250
Beef cattle manure: 0 to 40	$9	$35	$15	0.08	$200 - $600
Organics Diversion: 0 to -80	$17	$23	$20	0.14	$150 - $300
RSG (~10-point reduction)	$0	$0	$0 - $0.05?	0.01	$0 - $5

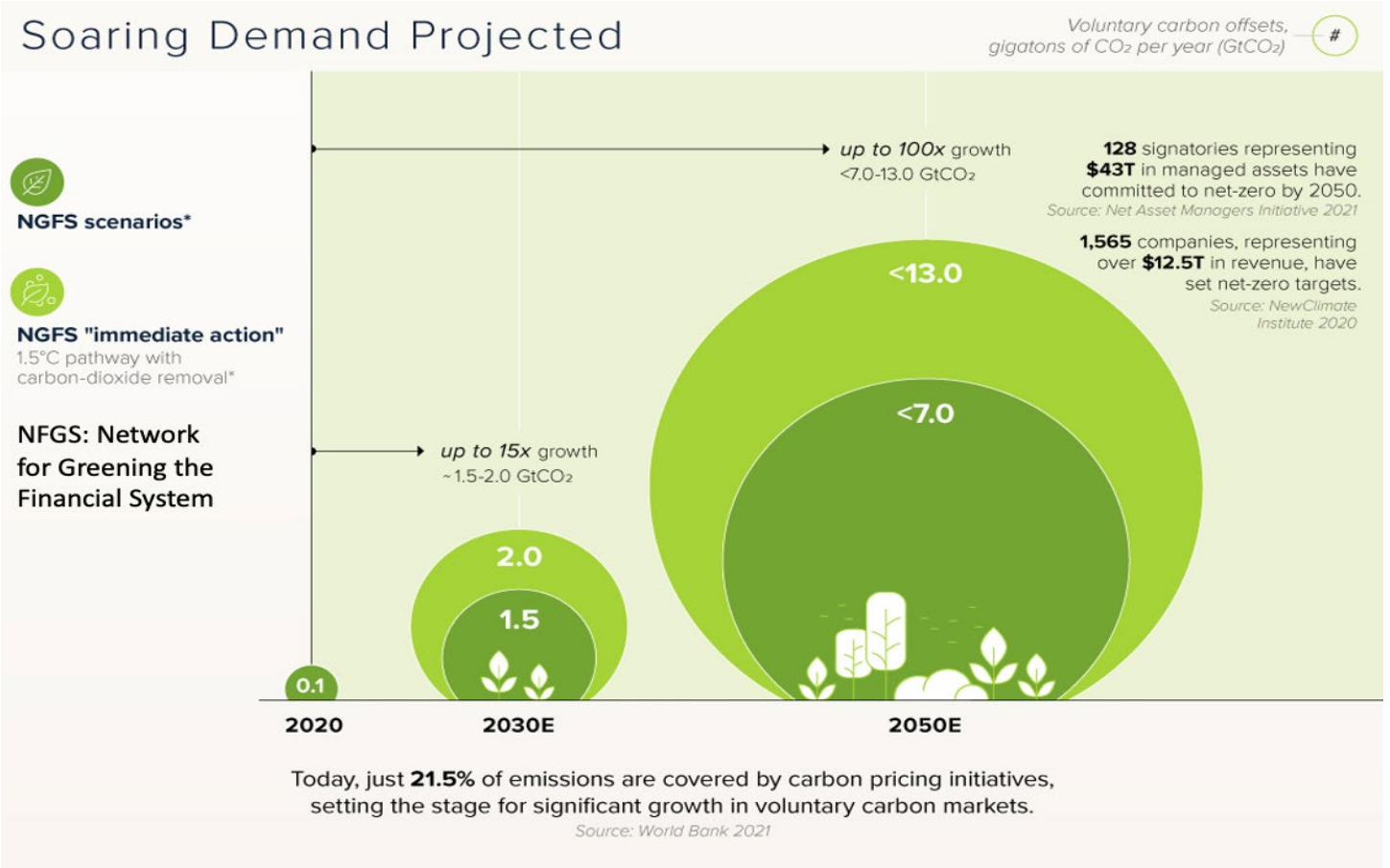
Takeaways from Previous Slide

- RINs and LCFS make California a very attractive market
- Voluntary buyers forced to pay more due to LCFS/RINs
- Voluntary prices/terms can act as floor for LCFS/RIN credits
- California uses diverse set of policies for organics diversion and dairy methane
  - Trying to balance environmental, economic, and environmental justice priorities
- Methane reduction from RSG is a key overlooked market
- Without LCA, pricing makes no sense

Voluntary Carbon Offsets to Grow 15x by 2030, But Very Diverse Impact Categories

- **Global warming potential (CI)**
- Stratospheric ozone depletion
- Fine particulate matter formation
- Terrestrial ecosystems/ecotoxicity
- Freshwater/marine eutrophication/toxicity
- Human health/toxicity
- Mineral/Fossil resource scarcity
- Water consumption
- Social impacts

- New, holistic LCA models are emerging



Source: McKinsey & Company

RNG CI Example for Dairy RNG

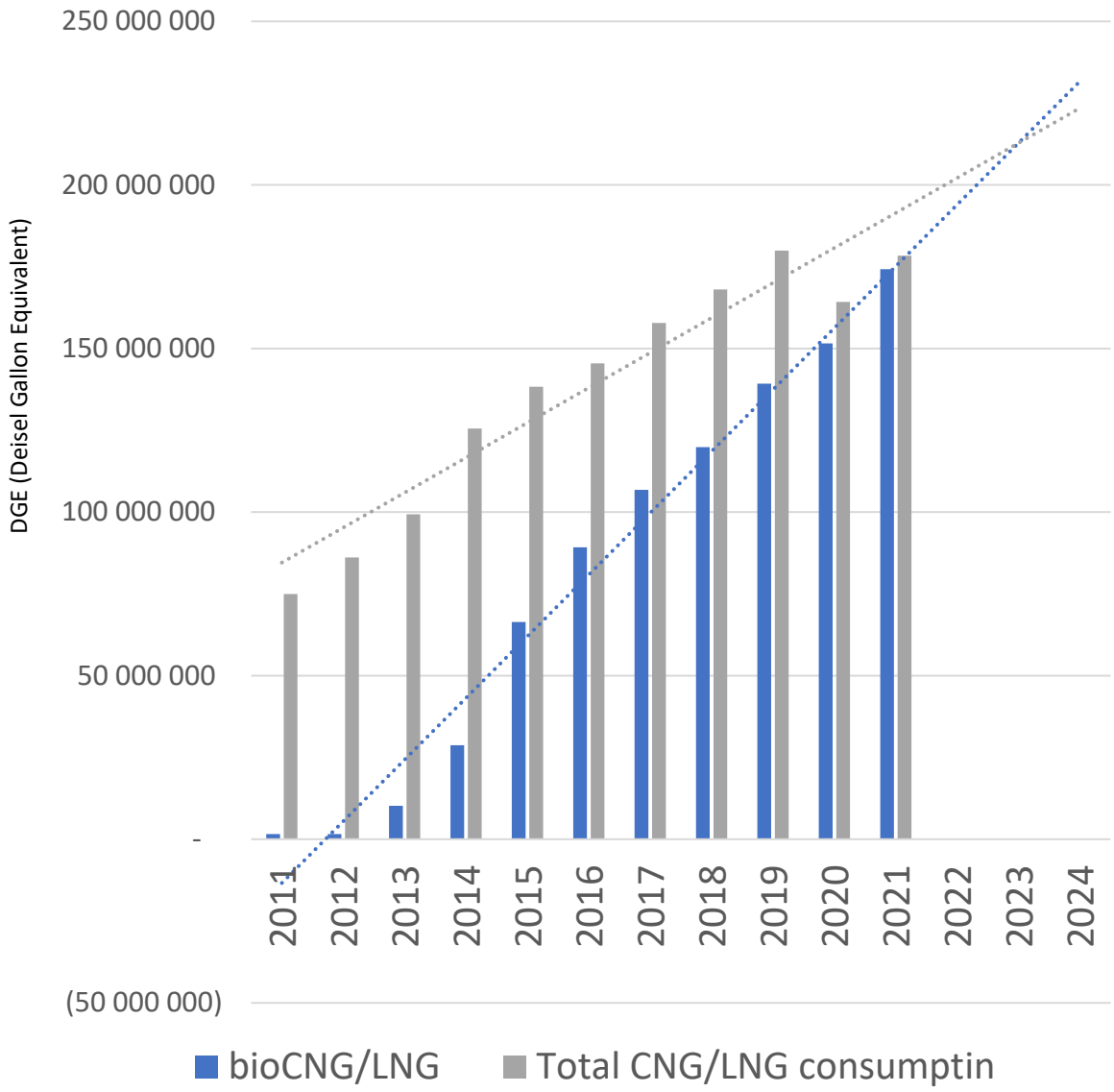
- Customization of LCA models
- Address local/regional, environmental and economic priorities
- Establish reasonable baselines and rules for additionality
- Stakeholder input

Input	CI (gCO_2e/MJ)	Model Design under LCFS
Manure Handling	0	User control
Grid electricity for upgrading	10	Limited user control
Utility source NG for biogas production and upgrading	20	Limited user control
Biomethane flaring	0	User Control
Fugitive Emissions	10	Almost fixed
Transmission	12	Proportional to distance, almost fixed
Compression	3	Fixed
Tailpipe	61	Fixed
Avoided emissions credits	**-316**	**Dependent on baseline vs. project volume**
Total	-200	

ecoengineers
people-driven solutions

The RNG Evolution in California

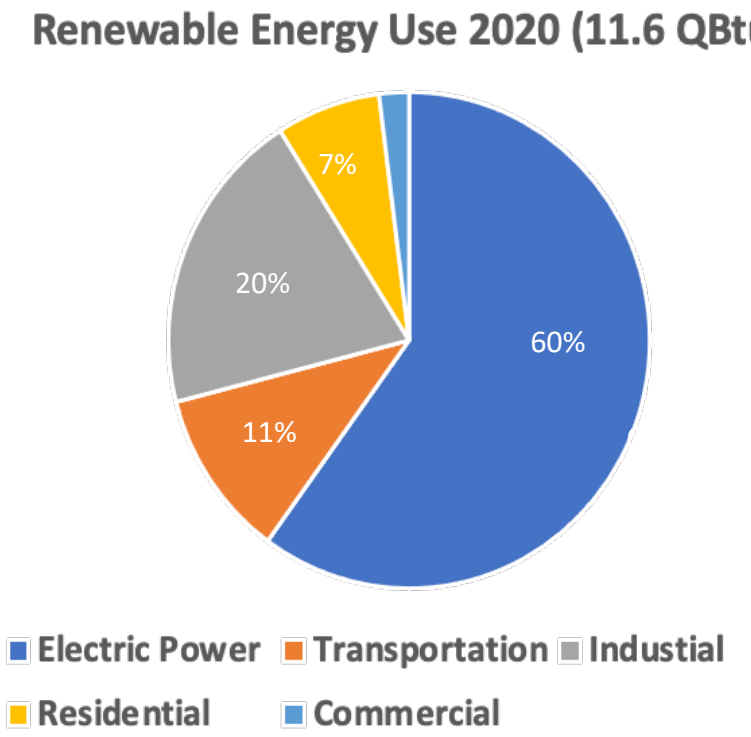
- Average CI for Bio-CNG:
  - 2018: 45 gCO_2e/MJ
  - 2019: 35 gCO_2e/MJ
  - 2020: -3 gCO_2e/MJ
  - 2021: -46 gCO_2e/MJ
- Average CI will continue to decrease
- ~150+ new animal manure projects in the pipeline

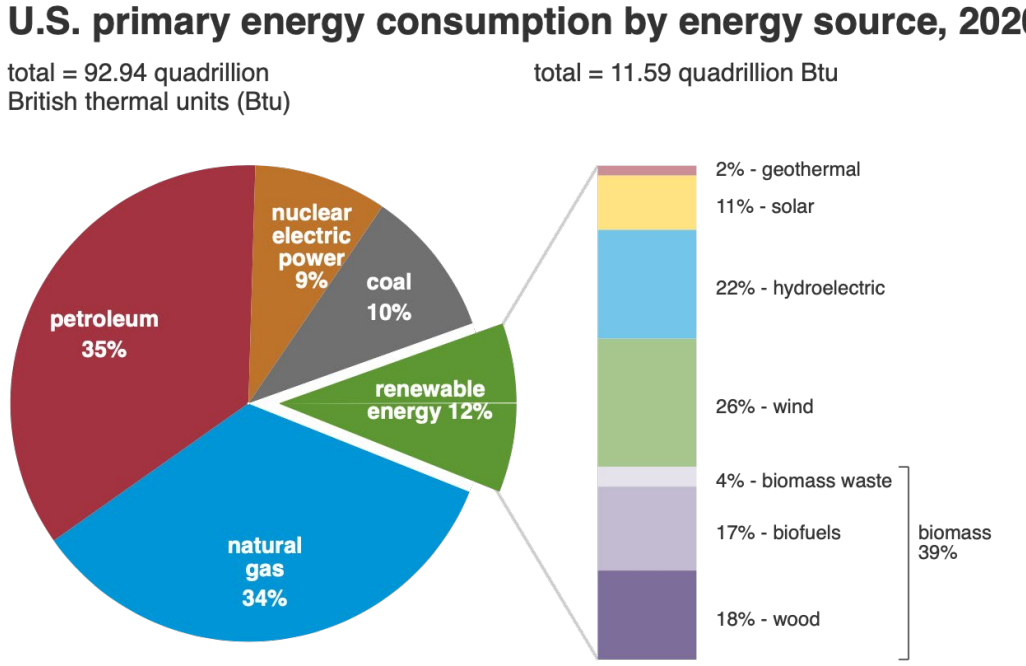


Source: EcoEngineers

ecoengineers
people-driven solutions

12% US Renewable Supply in 2020
~40% biomass

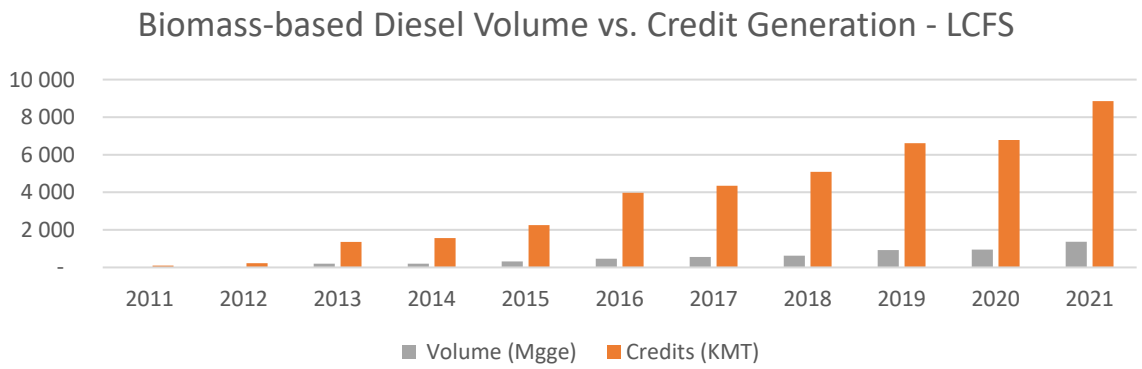


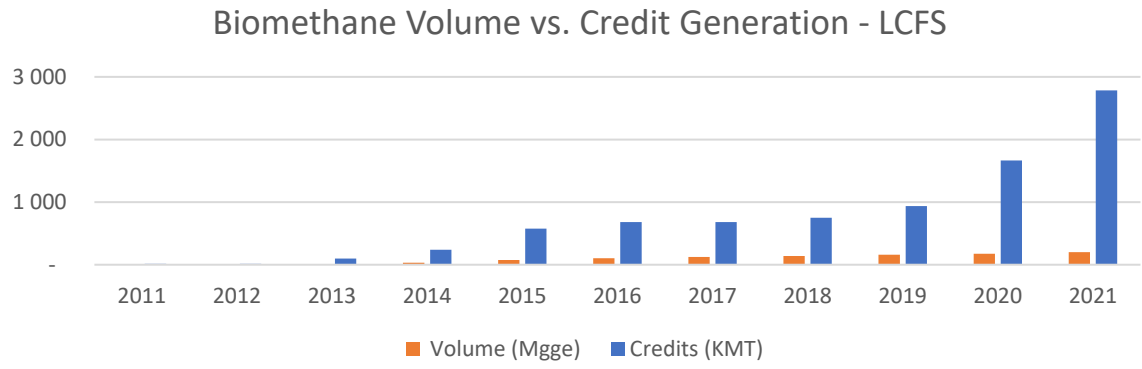


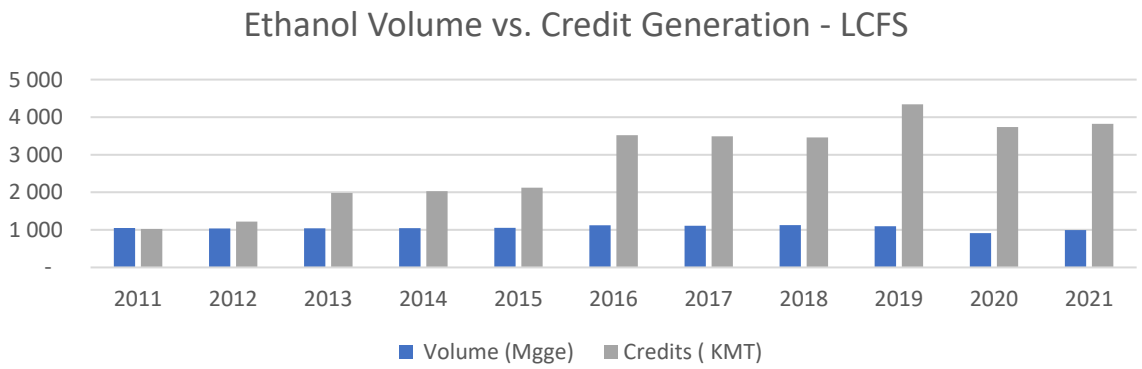
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2021, preliminary data
Note: Sum of components may not equal 100% because of independent rounding.

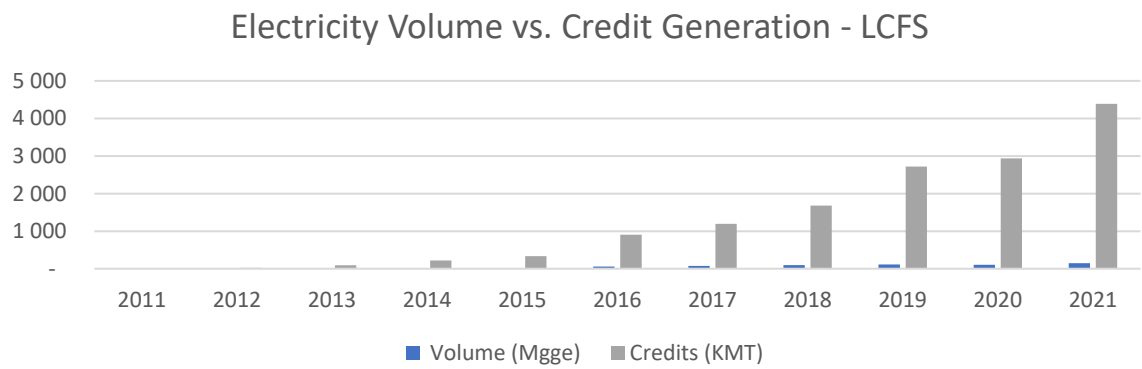
ecoengineers
people-driven solutions

Biomass is Dominant Energy Source Under LCFS - Ethanol, Biodiesel, Renewable Diesel, RNG









Source: EcoEngineers

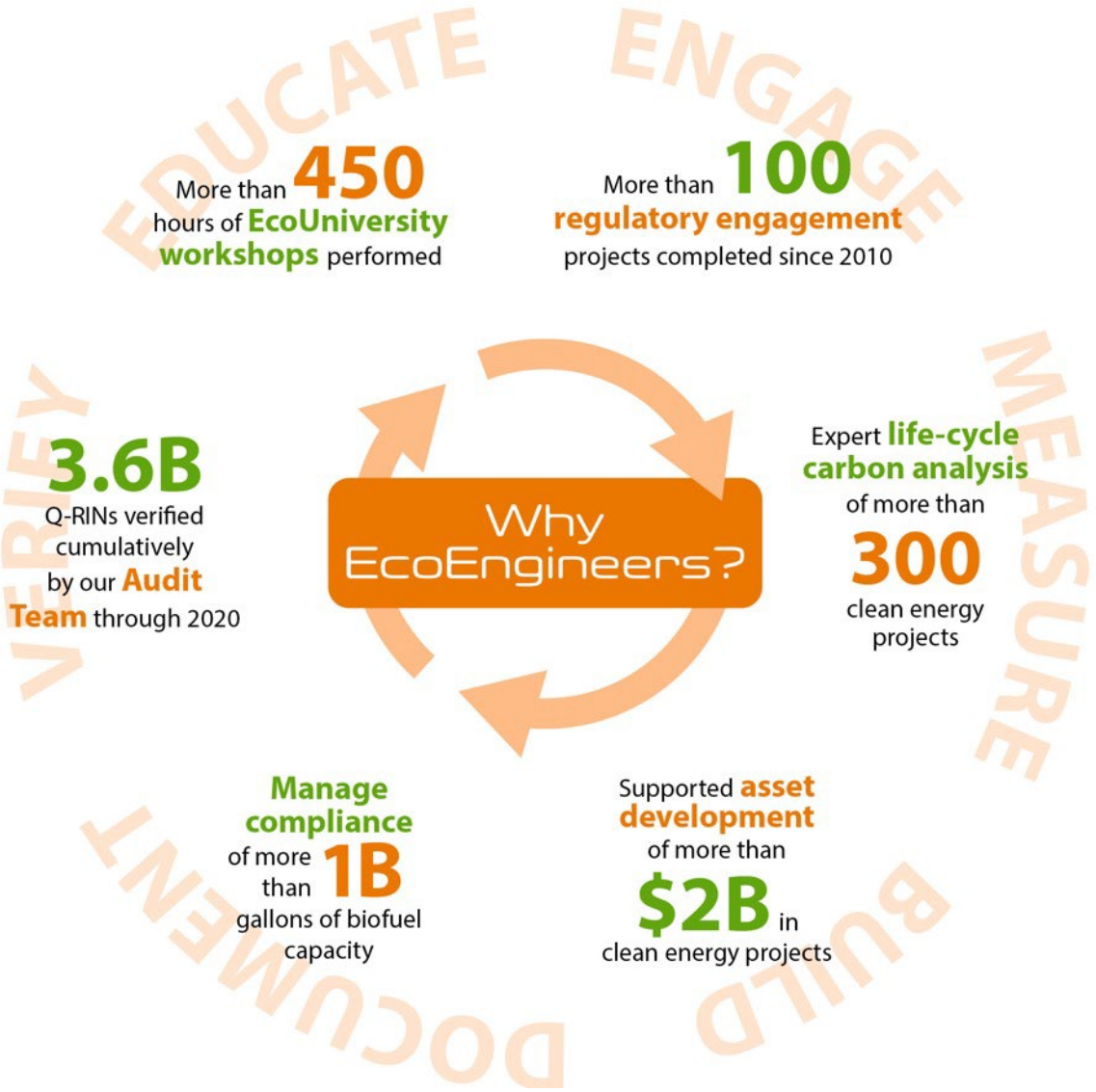
ecoengineers
people-driven solutions

Food *and* (low-carbon) Fuel is the Emerging Paradigm as Demand for Both Continue to Grow

- Fertilizer production and use
- Manure management practices
- Land use change (direct and indirect)
- Low-carbon practices – measurement and verification
- Alignment of fuel and food policies to reach net-zero goals

ecoengineers
people-driven solutions

We Help You Navigate the Carbon Economy



WE HELP YOU:

1. Learn regulations, technologies, and marketplace
2. Measure carbon
3. Engage with regulators /set internal policies
4. Assess risks, redirect capital, monetize carbon
5. Manage carbon compliance
6. Get third-party certification of carbon claims

RESULTS:

- Informed, confident decision making
- Understanding an unpredictable regulatory environment
- Rational analytics of risks and rewards
- Reliable revenue projections

ecoengineers
people-driven solutions

ecoengineers
people-driven solutions

Shashi Menon
smenon@ecoengineers.us