Northwest Carbon Markets

WSU Washington Dairy Carbon Markets Workshop

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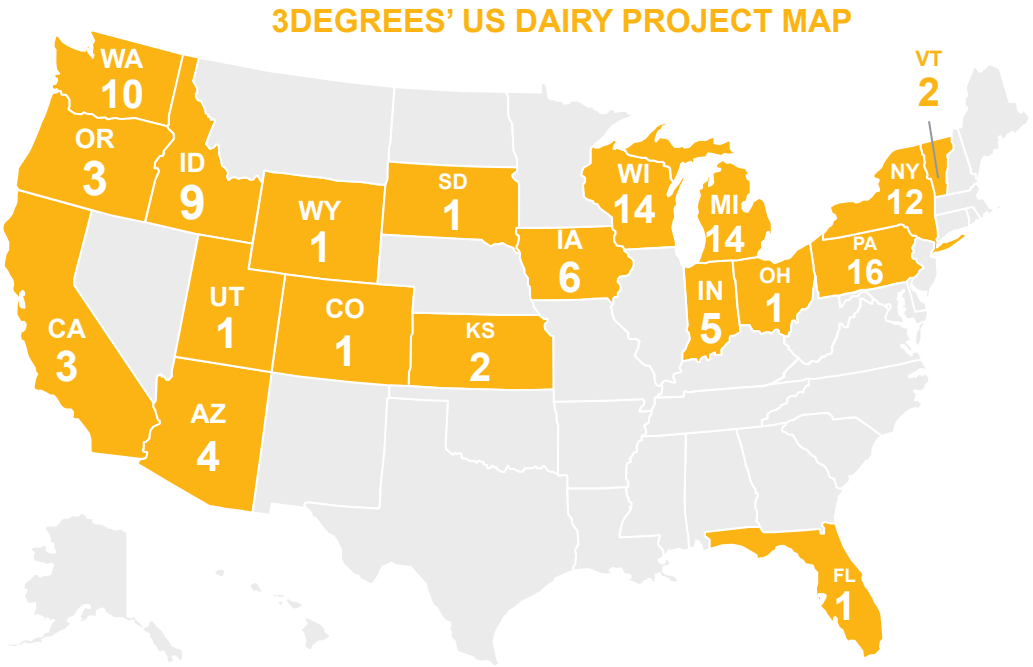
3Degrees - Carbon Developer

- Manage **credit creation** and **sale**
  - 15+ person team dedicated to credit development and management
    - Managed issuance of 20+ million credits
  - 60+ person team dedicated to credit sales across voluntary and compliance environmental markets
    - Over 600 corporate clients



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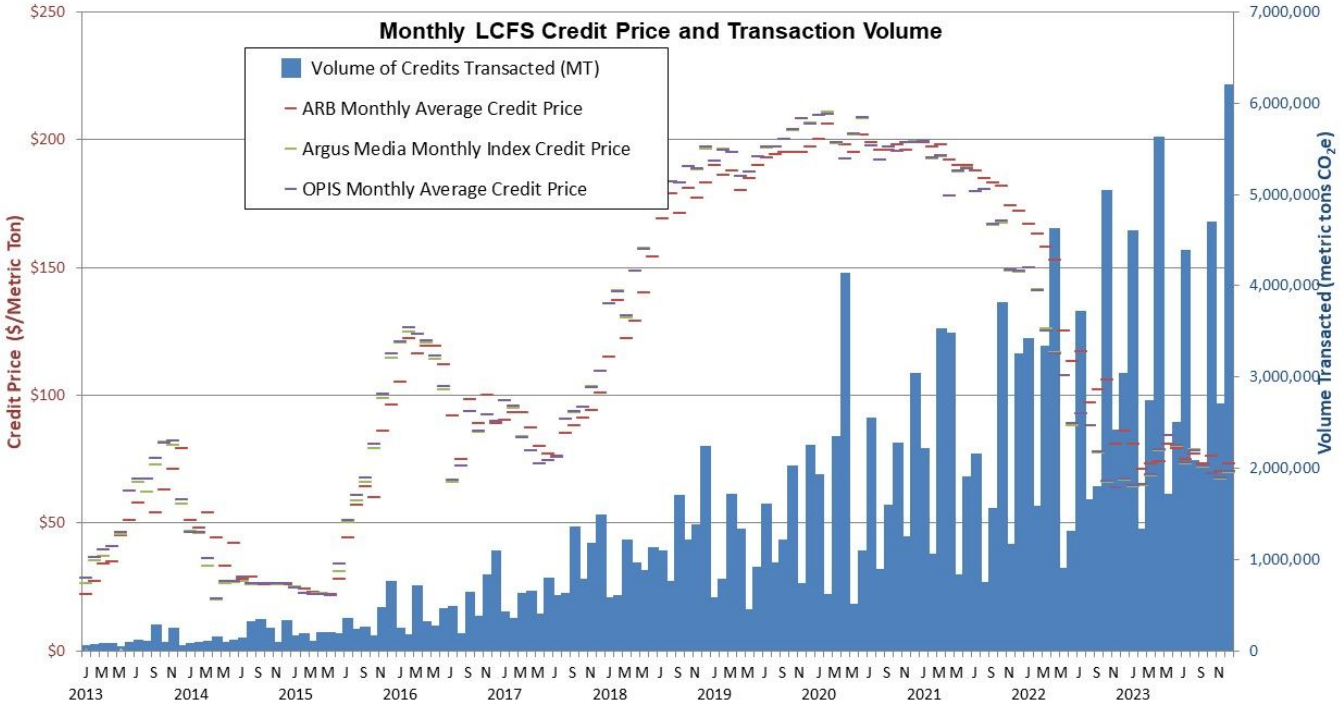
OVERVIEW

Environmental markets for manure management

Project type	Available market	Directional gross current value	3Degrees partners in Washington
Biogas electricity → electric vehicles	Clean Fuel Standard (California, Oregon, Washington)	$85 CO2e = $425/cow/year	Edaleen, Farm Power Rexville, Farm Power Rainier, Qualco
Renewable natural gas → CNG vehicles	Clean Fuel Standard (California, Oregon, Washington) + Renewable Fuel Standard	$200 CO2e = $1,000/cow/year	DeRuyter digester (RNG)
Alternative manure management	Voluntary carbon markets; Value Chain Intervention market	$30/mtCO2e = $150/cow/year	Royal Dairy vermifiltration; Skyridge chemical flocculants

Pricing - California

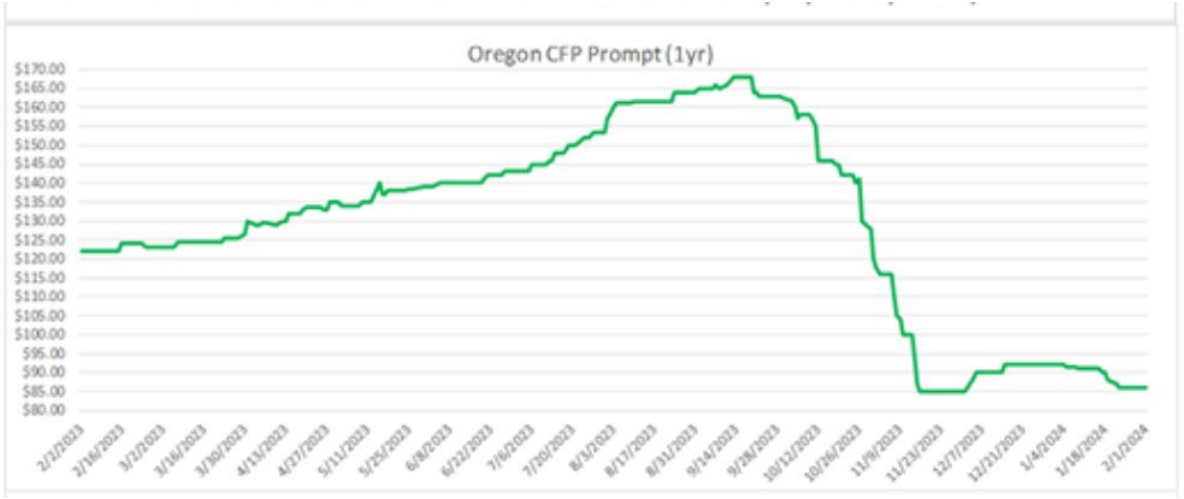


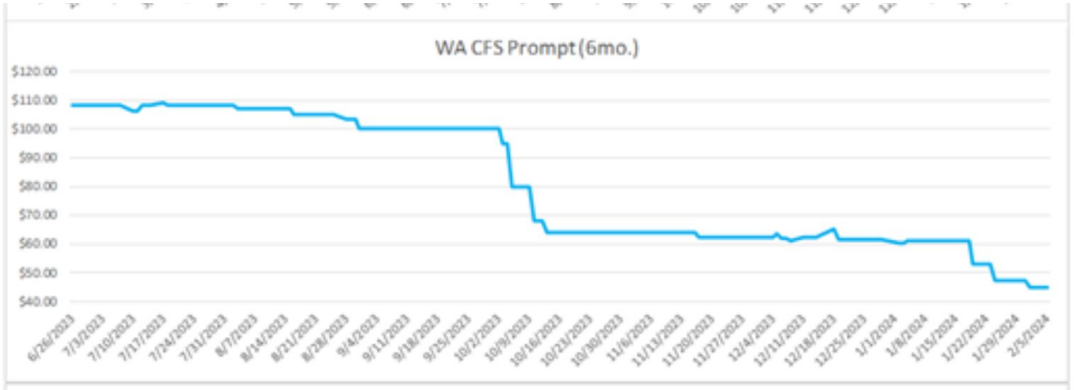
Source: California Air Resources Board

Last Updated 01/15/2024

CLEAN FUEL STANDARD

Pricing





Source: Evolution Daily LCFS Report for 2/2/2024

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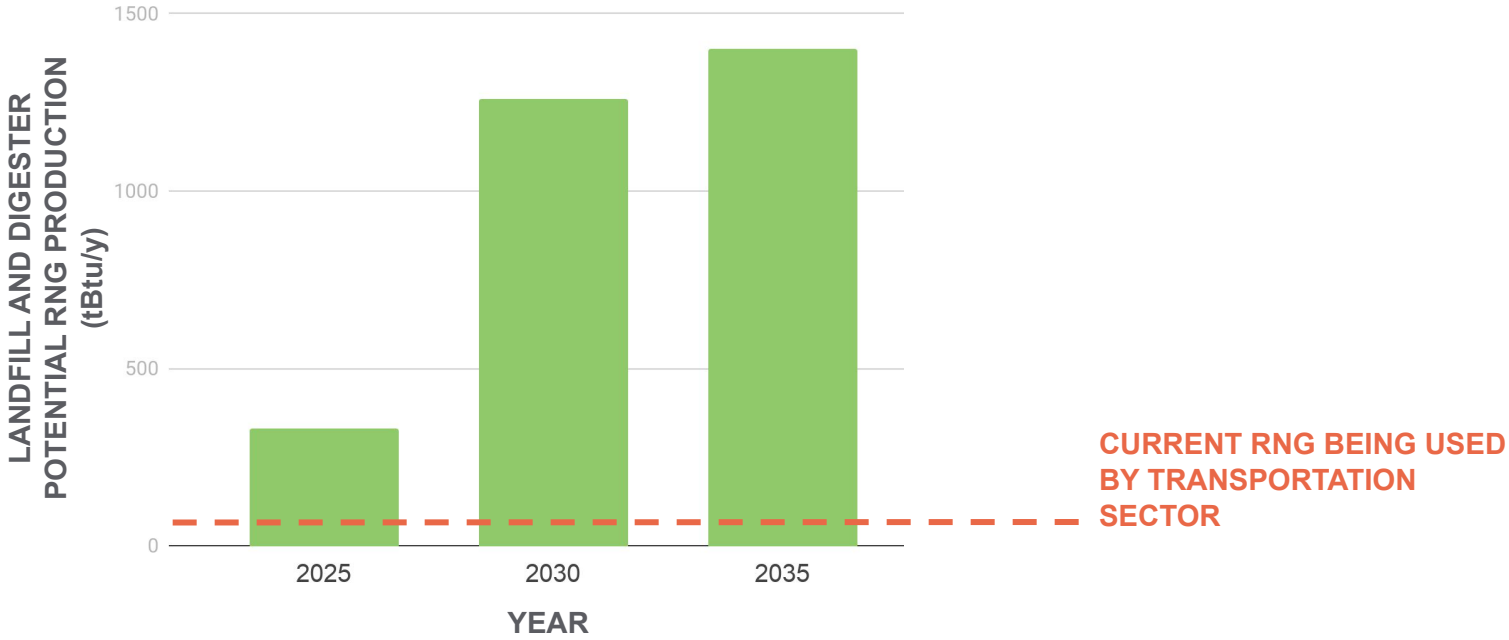
RIN values continue to heavily incentivize biogas projects to make renewable natural gas

- RIN = Renewable Identification Number under EPA's Renewable Fuel Standard
- Only RNG as generates Renewable Identification Numbers
- Directional value is based on Feb 2024 pricing
  - CA LCFS: $60/mtCO2e
  - D3 RIN: $2.85

	Dairy (-150 CI, D3)
Incremental LCFS Value ($/MMBTU)	$15
RIN Value ($/MMBTU)	$30
Combined ($/MMBTU)	**$45**
Producer 85% ($/MMBTU)	**$38**

But… RNG projects rely on limited CNG vehicle fueling



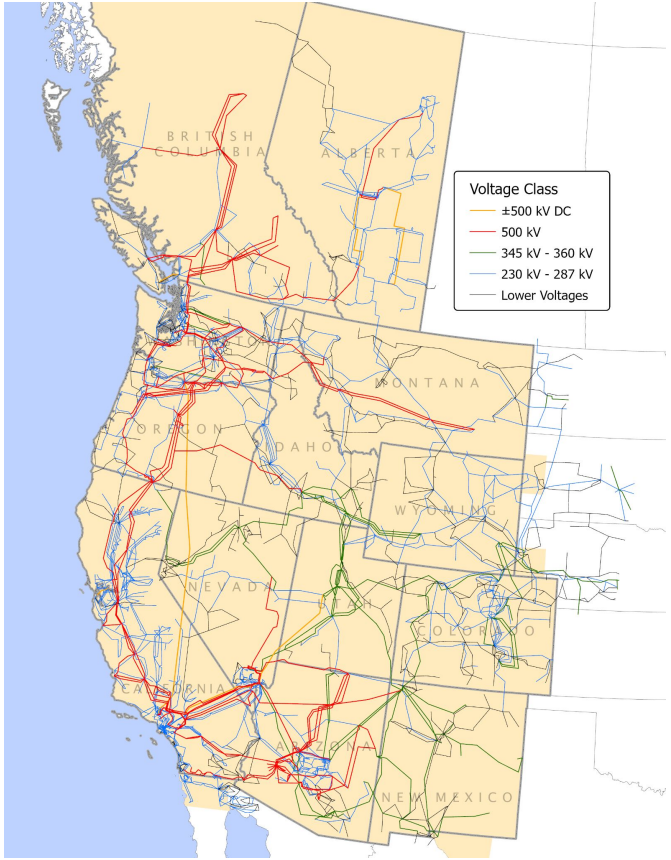
Source: Estimate of RNG potential production from landfills and anaerobic digesters under a "high resource scenario" from American Gas Foundation. Renewable Sources of Natural Gas: Supply and Emission Reduction Assessment. December 2019.

Project requirements

- *Geography*. Projects must be in the Western Interconnection, part of the Western Electricity Coordinating Council.

- *Carbon intensity*. Projects must have a negative carbon intensity, digesting **livestock manure** and/or previously landfilled **food waste**.

- *Environmental attribute ownership*. Projects must own all Environmental Attributes, both their
  - renewable electricity (RECs) and
  - avoided methane benefits (carbon credits and/or clean fuels standard credits)



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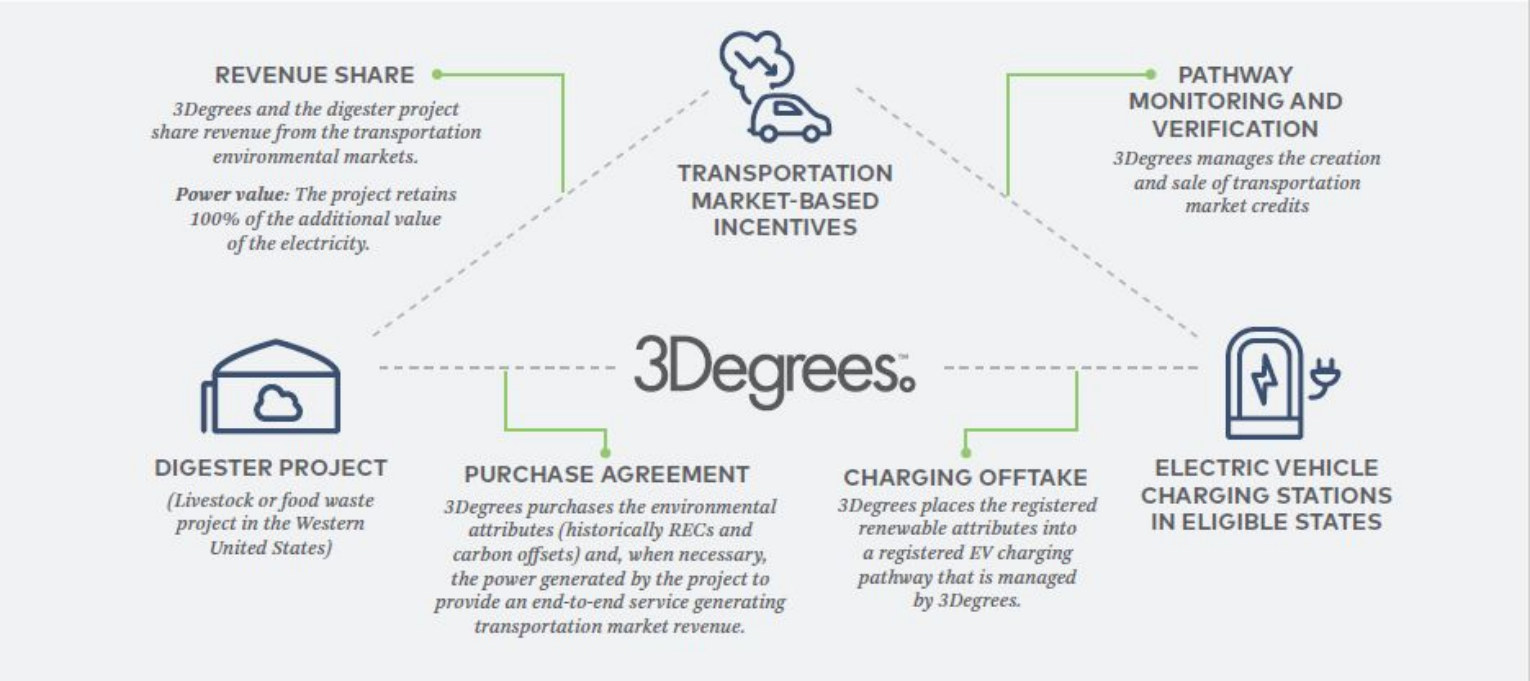
BIOGAS-TO-ELECTRIC VEHICLES

Registration Process



COMMON CHALLENGES

Small assumptions have a big impact on environmental attribute value

Common baseline complexity	**Carbon intensity impact**	**Annual revenue impact**
Lagoon cleanout - full vs partial clean out	40 gCO2e/MJ	→ $800,000
Solid separation efficiency - sampled vs default	70 gCO2e/MJ	→ $1.3 million
Drylot manure collection - proving increased collection	50 gCo2e/MJ	→ $900,000

Annual revenue impact assumes a 3,300 milking cow project generating RNG at current Oregon Clean Fuels Program prices

Electric clean fuel standard gross value

	Carbon Intensity (gCO2e/MJ)	Incremental Credits (mtCO2e/MWh)	$/MWh (@ $85/mtCO2e)
Average (of 17 existing projects)	-527	1.9	$160
Least Valuable (of 17 existing projects)	-108	0.4	$35
Most Valuable (of 17 existing projects)	-762	2.7	$230
Manure-only (theoretical)	-600	2.2	$190
Manure + co-feed (theoretical)	-175	0.6	$50

Voluntary and supply-chain market is creating opportunity for non-digester projects

- Advanced manure management
- Fertilizer management
- Enteric fermentation

3Degrees WA example: Royal Dairy Biofiltro Vermifiltration

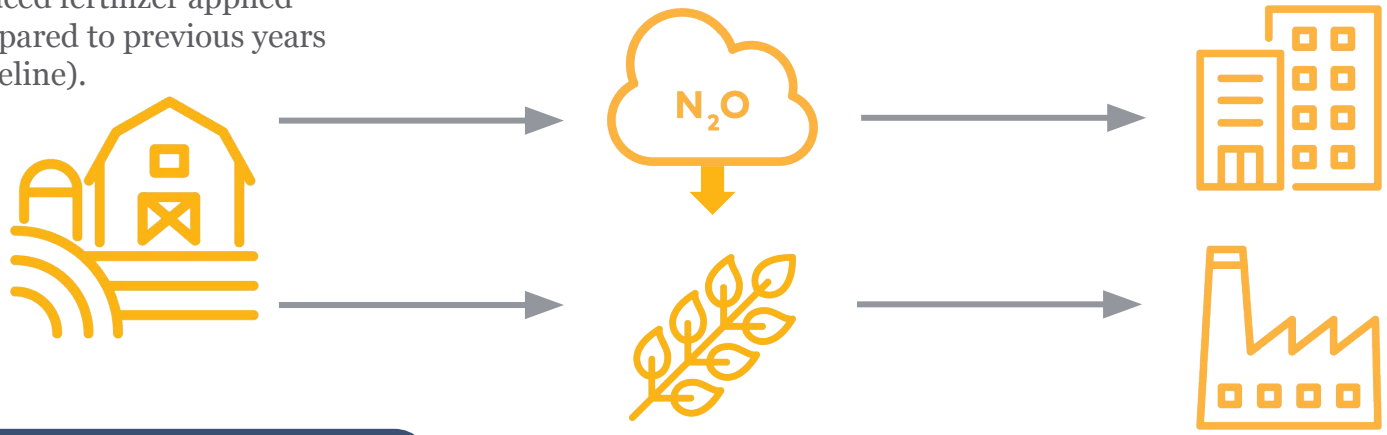
3Degrees WA example: Skyridge Dairy
Livestock Water Recycling First Wave System

Carbon credits unbundle environmental benefits

A farm grows corn with reduced fertilizer applied compared to previous years (baseline).

The fertilizer reductions result in fewer N2O emissions (converted to tCO2e)

The reduced emissions are sold as a carbon offset. The buyer can report the offset in their emissions reporting.



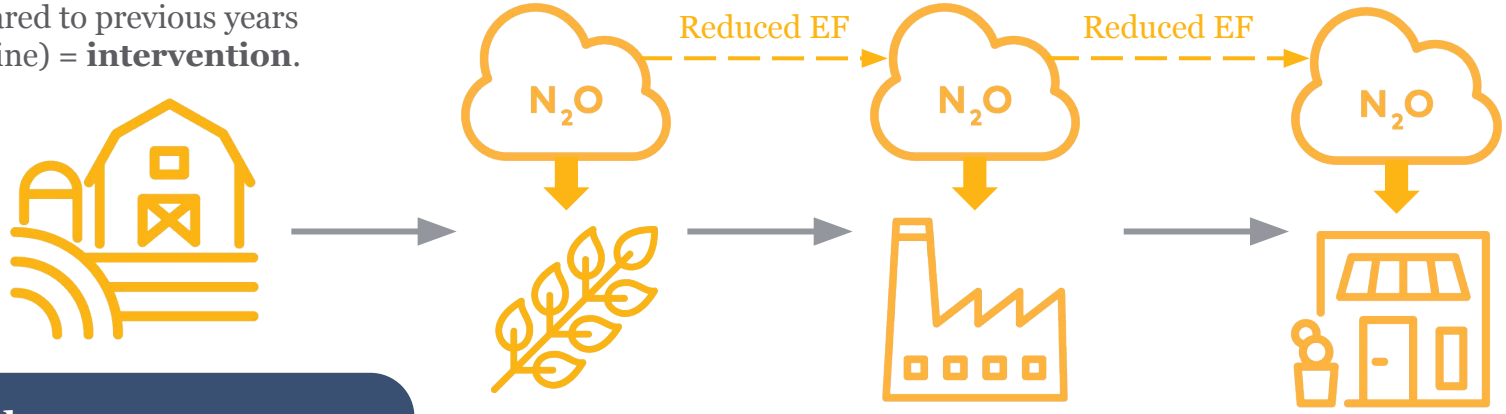
Key Takeaway:
Emission reductions are separate from products moving down the supply chain.

The corn crop is sold to a consumer packaged goods (CPG) company that makes breakfast cereal.

The CPG company makes breakfast cereals with reduced emissions but has no claim to those reductions.

Value Chain Interventions keep environmental benefits bundled with the product

A farm grows corn with reduced fertilizer applied compared to previous years (baseline) = **intervention**.



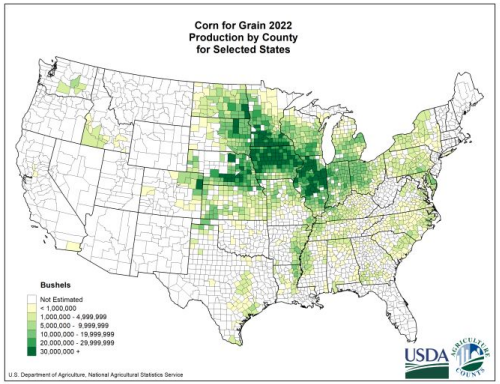
Key Takeaway:
Emission reductions are tied to the product and move down the supply chain as an emission factor.

The emission reductions are tied to the corn crop as tCO2e per bushel (volumetric unit) of corn grain. This results in a reduced emission factor (EF) for the corn that travels down the supply chain to the end user.

Land O'Lakes Project Scope

ValueChange

SUSTAINCERT
KNOW YOUR IMPACT



32 fields in Iowa and Minnesota

Corn grown with reduced emissions via reduced fertilizer

Corn with reduced EF is processed into animal feed

Animal feed with reduced EF is fed to dairy cows

Milk with reduced EF is processed into butter

Scope of project validation & verification only covers farm to feed processing facilities.

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