

# Innovative Crude Production Method

## Reduce O&G E&P CI +60%

### Clean Chemistry Reduces Steam Emissions

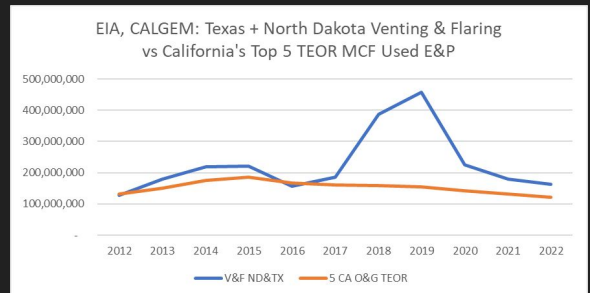
Benefits underserved and disadvantaged communities

1. California Air Resources Board is charged with reducing 90% of the oil industries upstream emissions by 2045. The CRSE innovative method is capable of reducing California's upstream carbon intensity 60% when fully adopted by eliminating the second largest O&G emission source; reducing the need for fossil fuel (natural gas); using a non-toxic, vegetable based chemistry that is extremely effective penetrating and mobilizing heavy viscous oil; and eliminating steam in Thermal Enhanced Oil Recovery extraction and production operations. Most heavy oil is located in Kern County (7 of 9 largest fields); and 94% of the TEOR oil comes from 5 companies.

# #1 & #2 Highest O&G Emission Sources

## #1 - Natural Gas Venting and Flaring

ND & TX 2022 = 163,783 MMCF

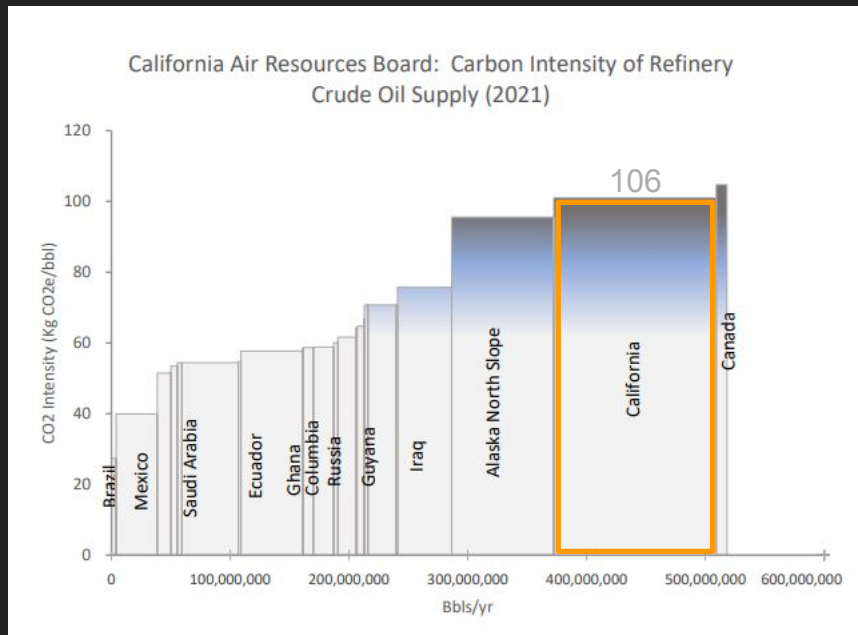


## #2 - Steam Generation Thermal Enhanced Oil Recovery (TEOR)

5 TEOR Operators = 121,783 MMCF burned for 94% total steam.

California oil has significantly higher Carbon Intensity than other refined crudes

Current emission focus is on venting and flaring, which is the largest and most dangerous emission source. No one talks about #2, which is emissions from steam generation for heavy oil. California is by far the largest producer of thermal heavy oil, which uses steam to mobilize heavy oil. The steam oil ratio (SOR) is the efficiency measure of these TEOR operations. Natural gas is burned to create steam; the steam is injected into the oil formations, heating the formation and fluids contained within so oil can be extracted. The steam injected can be easily related to natural gas burned and emissions released into the atmosphere based on the SOR. The higher the SOR, the more steam per barrel of oil is required, creating a higher-carbon intensity crude.

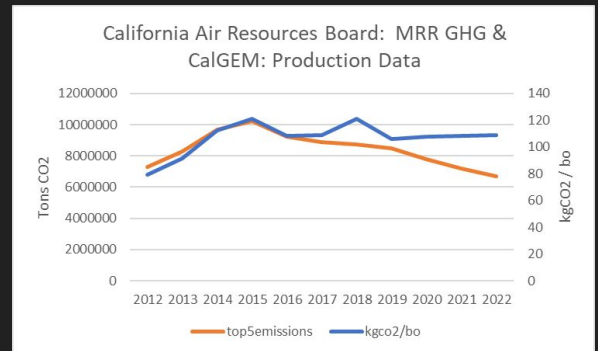
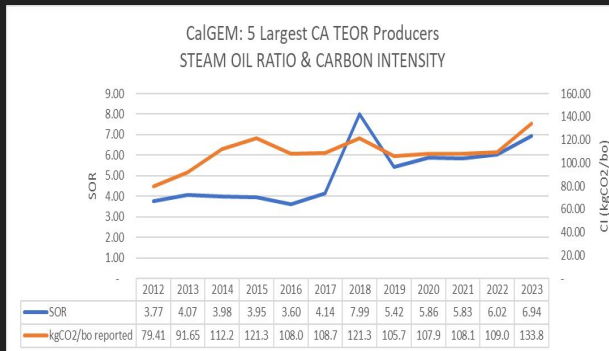


California's TEOR production accounts for about 70% of California's total oil production, responsible for nearly 28% of all emissions. The carbon intensity of all California oil production is significantly driven by steam injection.

# Carbon Intensity $\approx$ Steam Oil Ratio, SOR, in TEOR

Baseline Scenario uses steam to produce oil, known as SOR.

$$CI = \text{Steam}_{\text{emissions}} / \text{Oil}_{\text{vol}} \approx \text{SOR}_{\text{baseline}} = \text{Steam}_{\text{vol}} / \text{Oil}_{\text{vol}}$$



The carbon intensity = emissions / economic product - oil in this case in the baseline scenario compares to what is called the SOR. The SOR is correlated to CARBON INTENSITY - as shown in the chart on the left. This is the 5 largest heavy oil producers in California; reflecting the SOR and the CI of this crude production. The graph to the right demonstrates, even as emissions drop, and steam injection declines, the carbon intensity will continue to increase. How can oil companies lower the CI of their crude oil? They reduce steam; oil drops - leading to higher CI number. CRSE without steam emissions, however, reduces steam emissions and lessens the decline rate.

# Carbon Intensity $\approx$ Steam Oil Ratio, SOR, in TEOR

Innovative Method uses clean chemistry, not steam, to produce oil..

pH neutral, non toxic, biodegradable

Sourced from vegetable oil's

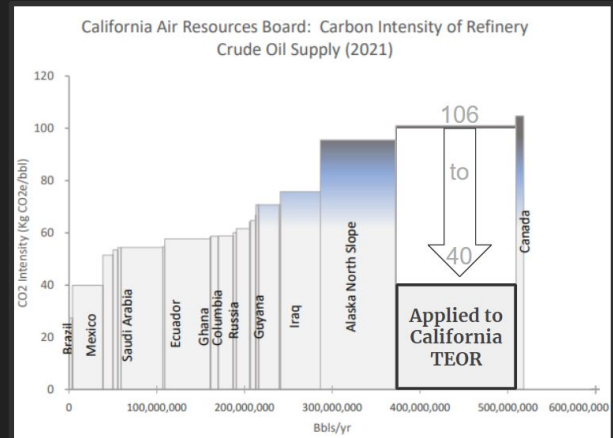
Reduces oil viscosity = replaces steam

100% adoption reduces TEOR CI 62%

Scalable to every well

No capital requirement

Only way to lower CI



Applying this CLEAN CHEMISTRY to replace steam, technically and economically, can be 100% adopted within a short timeframe, reducing the CI of California's oil by over 60%. This provides California refineries with a large source of domestic, local and clean oil. This is the perfect transition opportunity for California as this significantly reduces the CI of the refined crude.

## Economics: Gas at \$5.14 mcf<sup>1</sup>

Chemistry expense is \$15 / bo

Steam is economically preferential until SOR = 8.5

Fuel cost for 1 barrel of steam = \$1.80 / bo

LCFS Approval, economic preferential SOR drops to = 4.5

Today is 90% of California's TEOR fields SOR is > 4.5

1: Berry Petroleum public data purchases gas from Rockies for this price. <https://ir.bry.com/static-files/4333b22c-5f3e-4f60-bc45-48c181e9d060>. P. 22, \$5.34/mmbtu

Source for gas prices is reported by publicly traded Berry Petroleum for gas purchases from the Rockies for their steam generators: Q3 2023 is \$5.14 per mcf. Using a ratio of 2.85 barrels of steam per mcf burned, the cost for steam is \$1.80 per barrel of oil. Therefore, at a chemistry cost of \$15/bo, the economic hurdle is 8.5 SOR. An approved LCFS for Chemistry to Replace Steam would drop the economic hurdle to 4.5. That makes economic sense in over 90% of today's production, enabling the economical shift to this method, and eliminating millions of tons of carbon emissions in disadvantaged communities around Kern County.

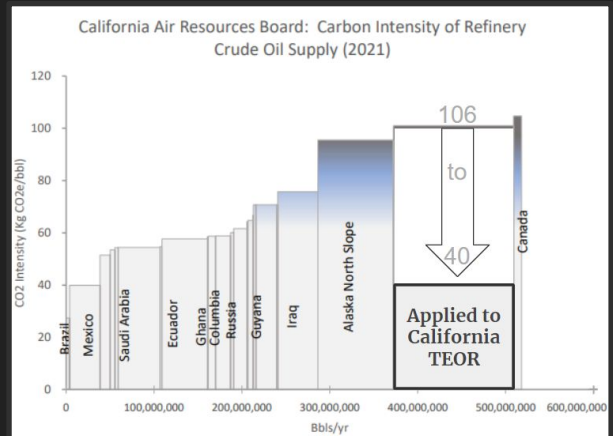
# Carbon Intensity $\approx$ Steam Oil Ratio, SOR, in TEOR

Innovative Method uses clean chemistry,

Reducing heavy oil viscosity

Without requiring steam.

$$\text{Steam}_{\text{vol avoided}} = \text{Oil}_{\text{innov}} * \text{SOR}_{\text{baseline}}$$



$$\text{Credits} = \text{Oil}_{\text{innov}} * \text{SOR}_{\text{baseline}} * \text{Steam}_{\text{emissions avoided}}$$

Here is the math: Clean chemistry is effective at reducing oil viscosity, which makes oil mobile. Steam does the same thing. We know a field's SOR; we know the volume of oil produced using Clean Chemistry; multiplying these two numbers provides steam avoided; multiplied by emissions of steam (reported by CARB); and credits are calculated.