Preliminary Analysis of Clean Fuels Policy on Air Quality and Public Health in Iowa and Minnesota

THE HOLLOWAY GROUP @ SAGE

Great Plains Institute
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Project Overview

- On behalf of the Great Plains Institute , we considered impacts from a 15% carbon intensity reduction via low-carbon fuels scenario in Iowa and Minnesota

- We estimated emission displaced due to these policies using the GREET model and then used COBRA to estimate resulting air quality and health benefits due to $PM_{2.5}$.

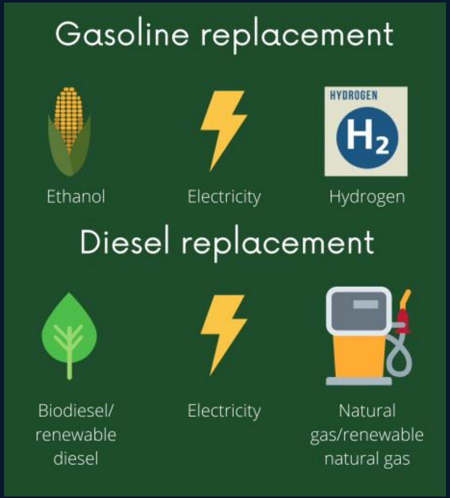


Image curtesy of https://lowcarbonfuels.colostate.edu/learn-more/

Using COBRA for this analysis

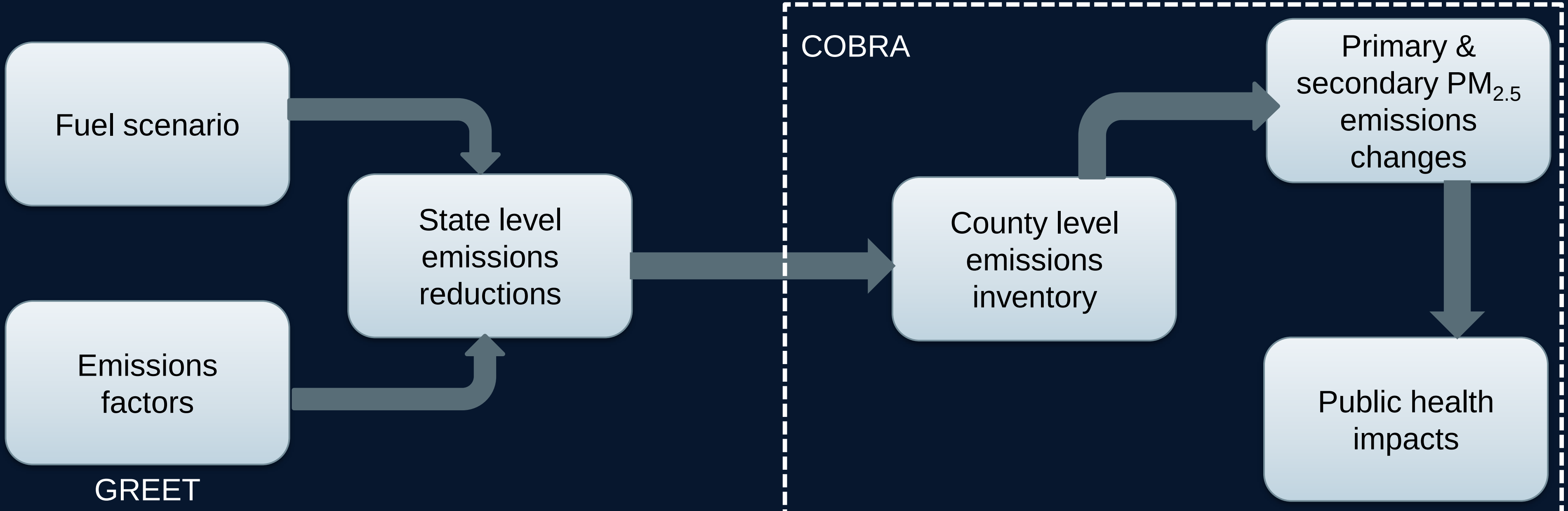
- CO-Benefit Risk Assessment (COBRA) model is a screening tool developed by U.S.EPA to access the public health impacts of air quality scenarios (EPA, 2020)

- This model includes a county-level emissions inventory including heavy duty and light duty highway vehicle tiers specifically relating to vehicle emissions.

- Emissions factors from GREET were used to estimate tailpipe emissions changes resulting from the proposed fuel scenario.

- COBRA approximates atmospheric chemistry and transport to estimate ambient PM2.5 reductions and then uses epidemiological "C-R functions" to translate air quality improvements into county-level health benefits .

Analysis flow chart



Fuel scenario

Emissions factors

GREET

State level emissions reductions

COBRA

County level emissions inventory

Primary & secondary $PM_{2.5}$ emissions changes

Public health impacts

15% Carbon Intensity Reduction Scenarios for Iowa and Minnesota Transportation Fuels.

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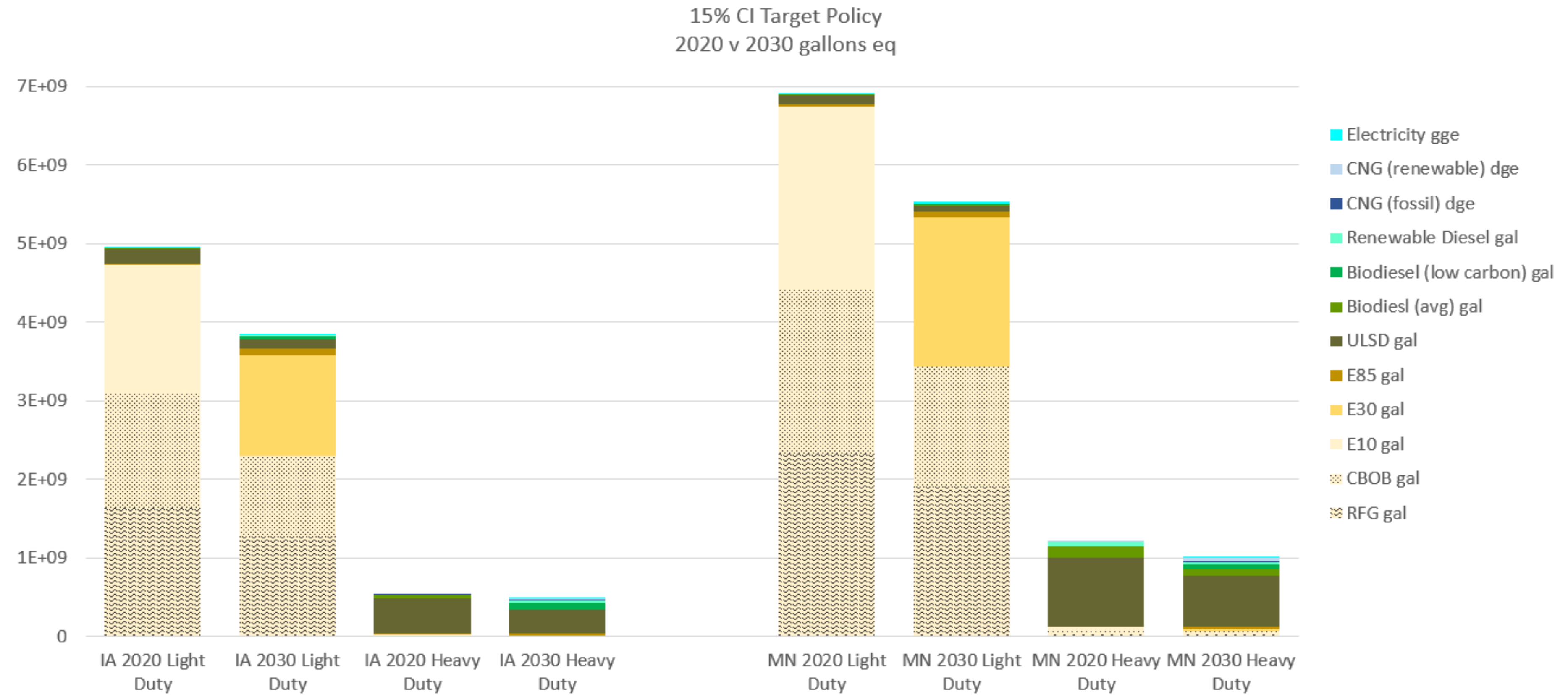

The Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model (GREET)

- We used GREET tail-pipe emissions (only) for NOx, SOx, PM, VOC for light-duty and heavy-duty vehicle / fuel combinations.

- Currently, feedstock production of fuels processing are not considered, more on this later.

Image curtesy of: https://greet.es.anl.gov/net

- Whereas GREET estimates are for a representative vehicle-fuel type, the COBRA model includes an emissions inventory reflecting the entire vehicle fleet. Two approaches considered: 1) calculate GREET-based emission reductions, and subtract from the established COBRA inventory, 2) calculate the weighted average of pre and post-policy emissions using GREET emission factors and apply this ratio (reduction) to the COBRA emission baseline.

GREET Tailpipe Emission Factors

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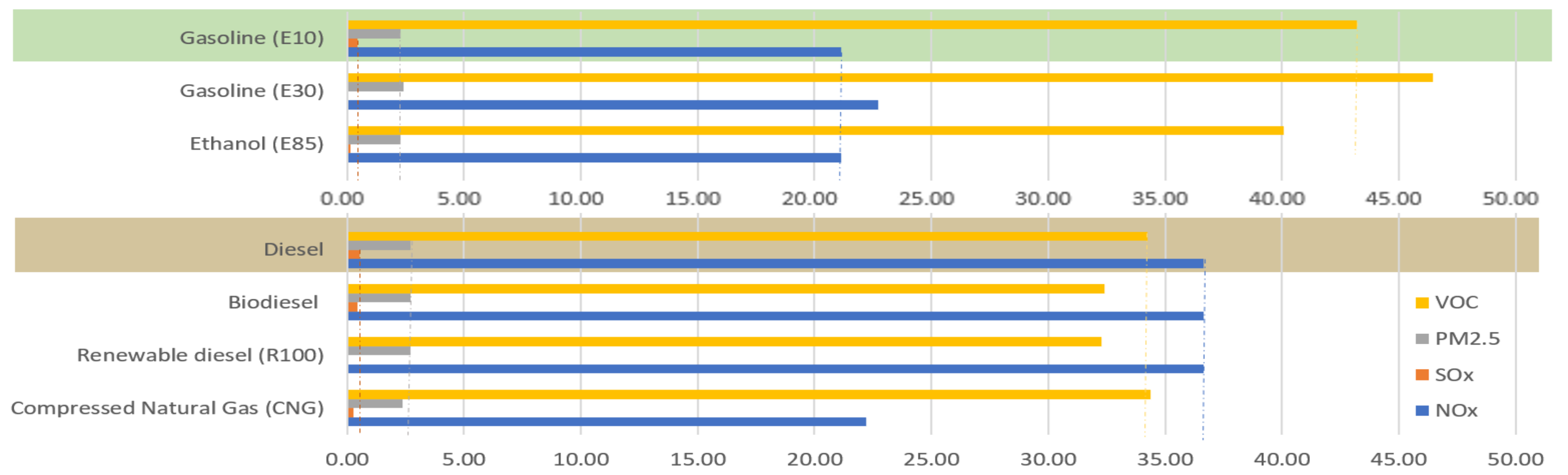
Light-Duty Vehicles (g/mmbtu)



- E85 tailpipe emissions reported lower than E10 for VOC and SOx.
- R100 tailpipe emissions reported lower than Diesel for VOC and SOx.
- SO_x are the only emissions that are lower for every alternative fuel.

GREET Tailpipe Emission Factors

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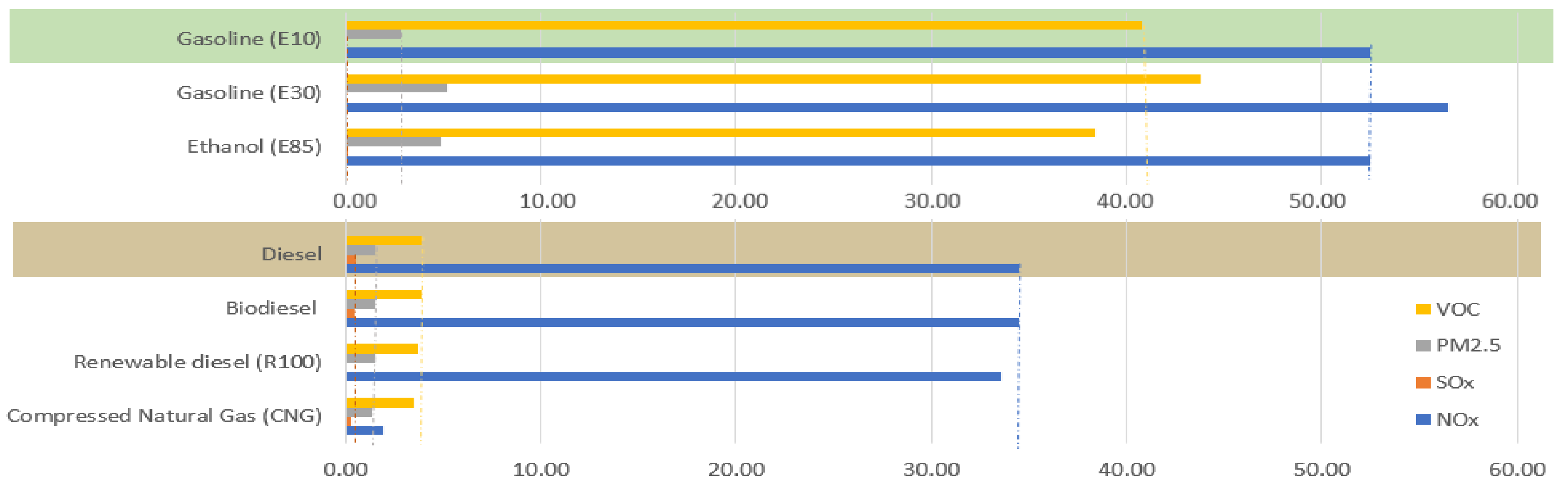
Heavy-Duty Vehicles (g/mmbtu)



- E85 tailpipe emissions reported lower than E10 for VOC but higher for $PM_{2.5}$.
- Gasoline and ethanol blends have much higher VOC than diesel and biodiesel.
- CNG has very low NOx emissions.

Emission Reduction Estimates
COBRA Highway Vehicle Inventory

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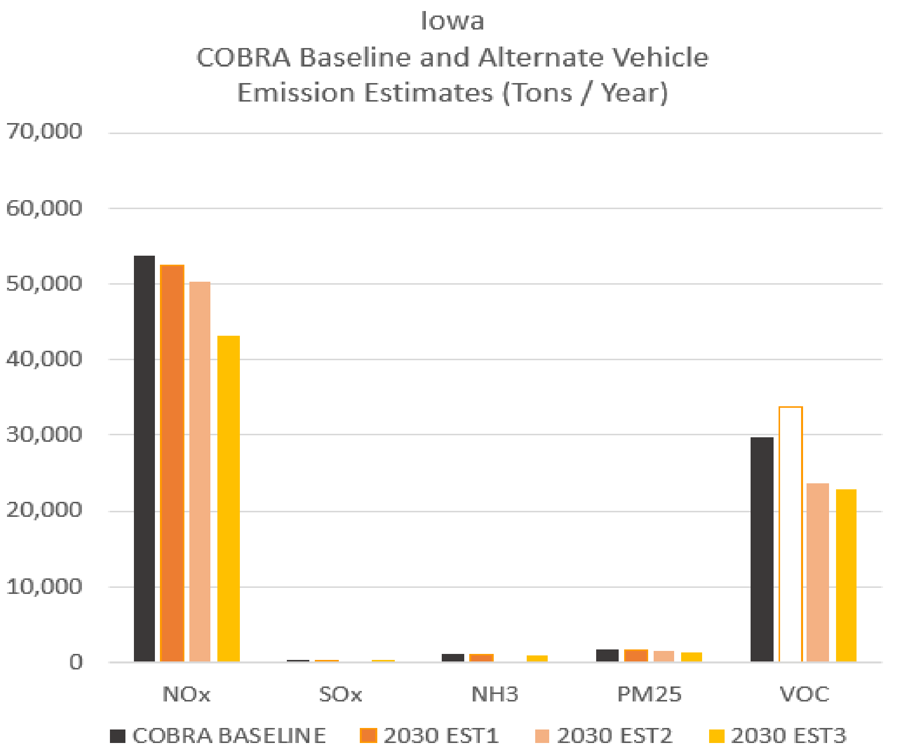
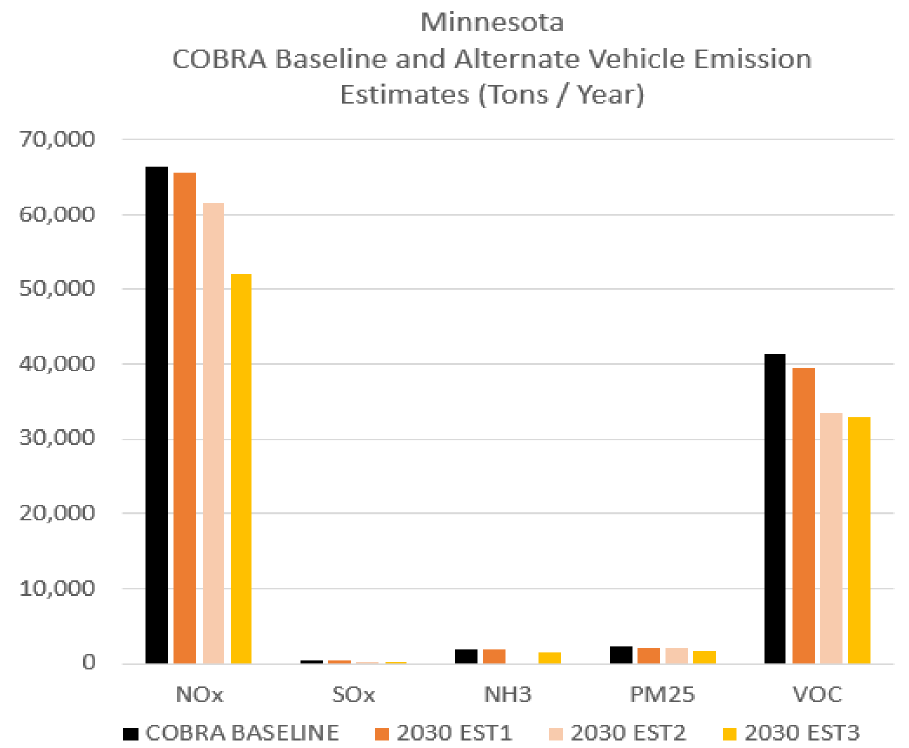




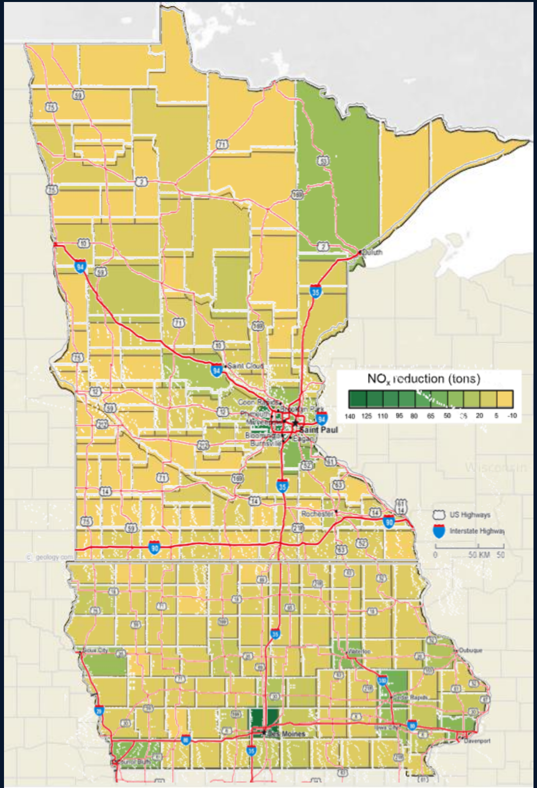
- Preliminary COBRA analysis based on the most conservative 2030 EST1 emission values.

State-level emission changes were distributed across the COBRA baseline

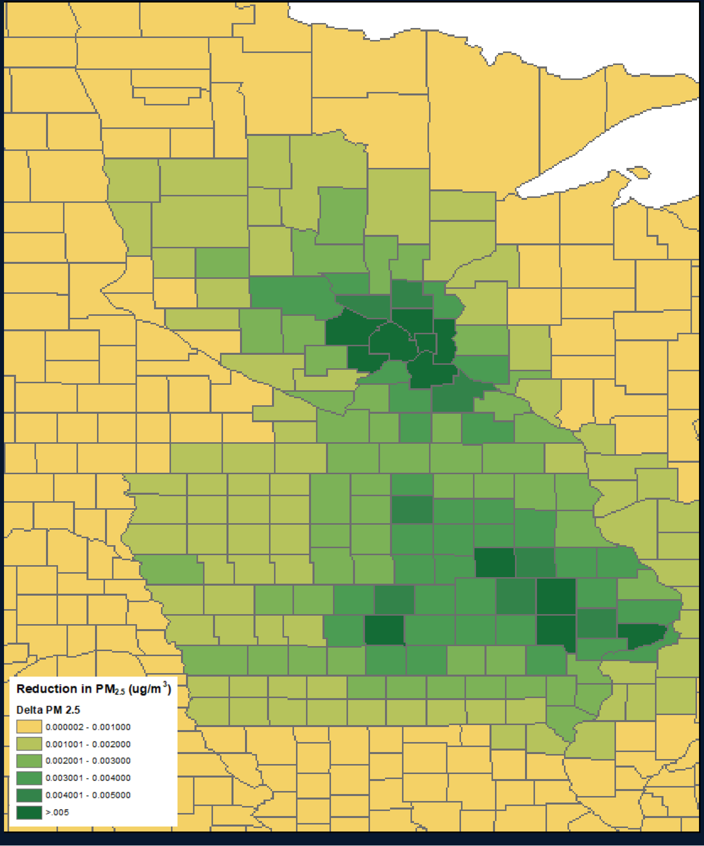
- Figure shows the reduction in NO_x (tons/year) by county resulting from the 15% CI fuel scenario using 2030 EST1.

- Statewide emission reductions are uniformly allocated to the county level proportional to the baseline emission inventory.

- Larger emission decreases are noticeable along interstate highways and in metropolitan areas.



COBRA-Estimated $PM_{2.5}$ Air Quality Improvements resulting from vehicle emission source reductions. Scenario 2030 EST1

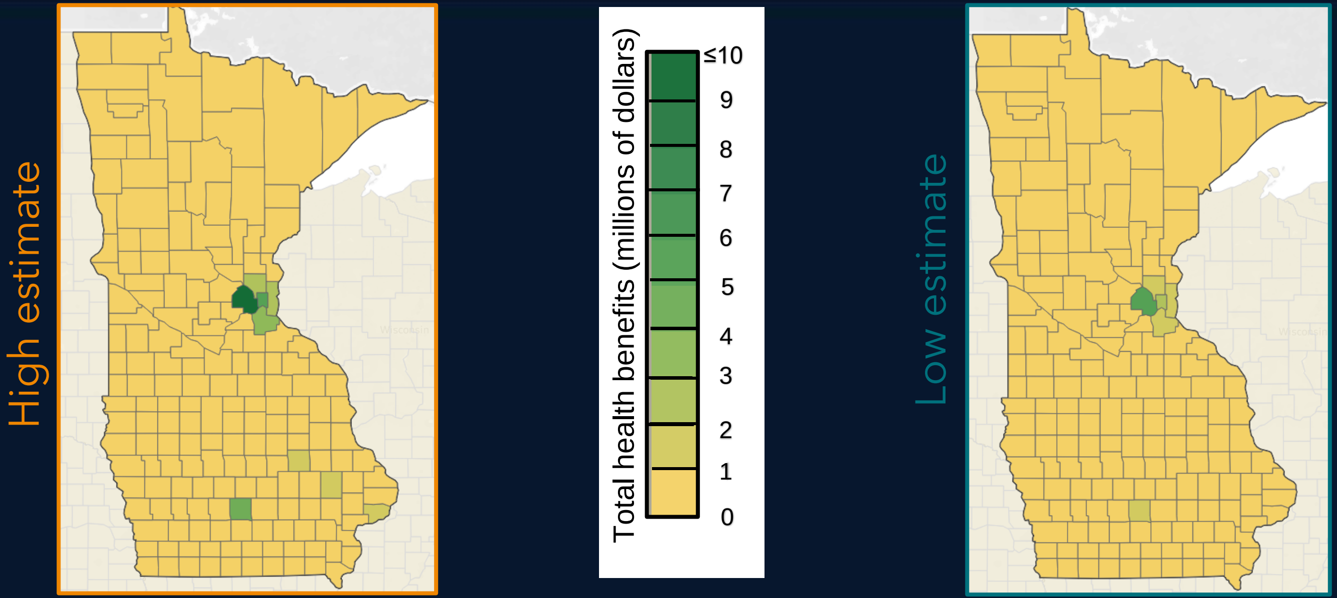


- COBRA uses the SO_x and NO_x emission changes to calculate secondary $PM_{2.5}$ emissions in addition to the primary $PM_{2.5}$ emissions calculated using the fuel scenario and GREET emissions factors.

- COBRA uses an atmospheric chemistry and transport to calculate the change of ambient air quality due to the changes in criteria pollutants.

- Here we see that the decrease in ambient $PM_{2.5}$ is larger for the more densely populated areas in Iowa and Minnesota

Total health benefits



	Total Annual Health Benefits (low estimate)	Total Annual Health Benefits (high estimate)
Minnesota	15,700,000	35,300,000
Iowa	7,540,000	17,000,000

COBRA estimated avoided non-fatal health impacts from the 2030 EST1 emission scenario.

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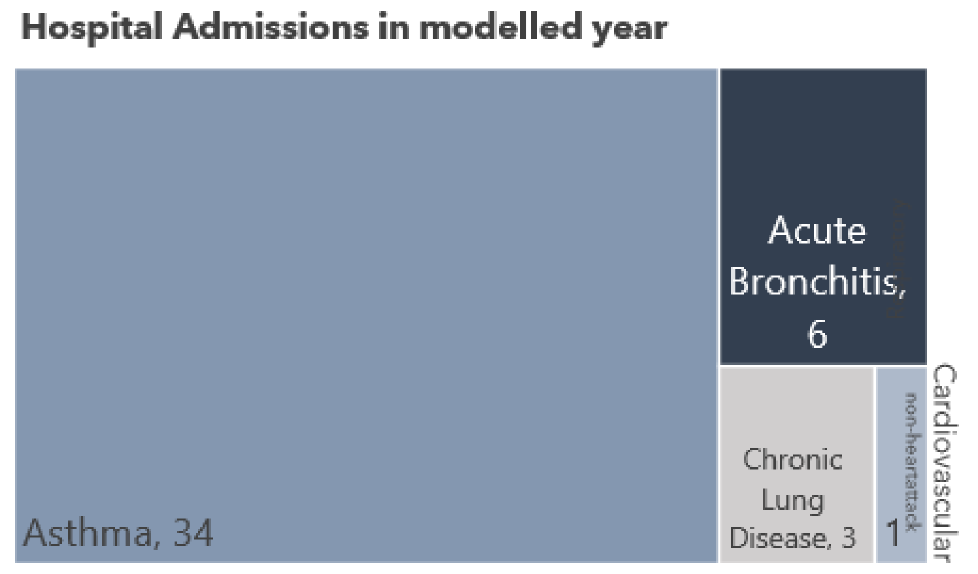
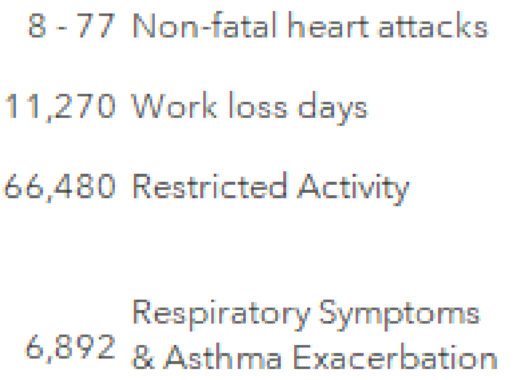
Avoided annual hospital visits.



Avoided annual non-fatal incidents



8 - 77	Non-fatal heart attacks
11,270	Work loss days
66,480	Restricted Activity
6,892	Respiratory Symptoms & Asthma Exacerbation

GREET reports significant feedstock and fuel production emissions.

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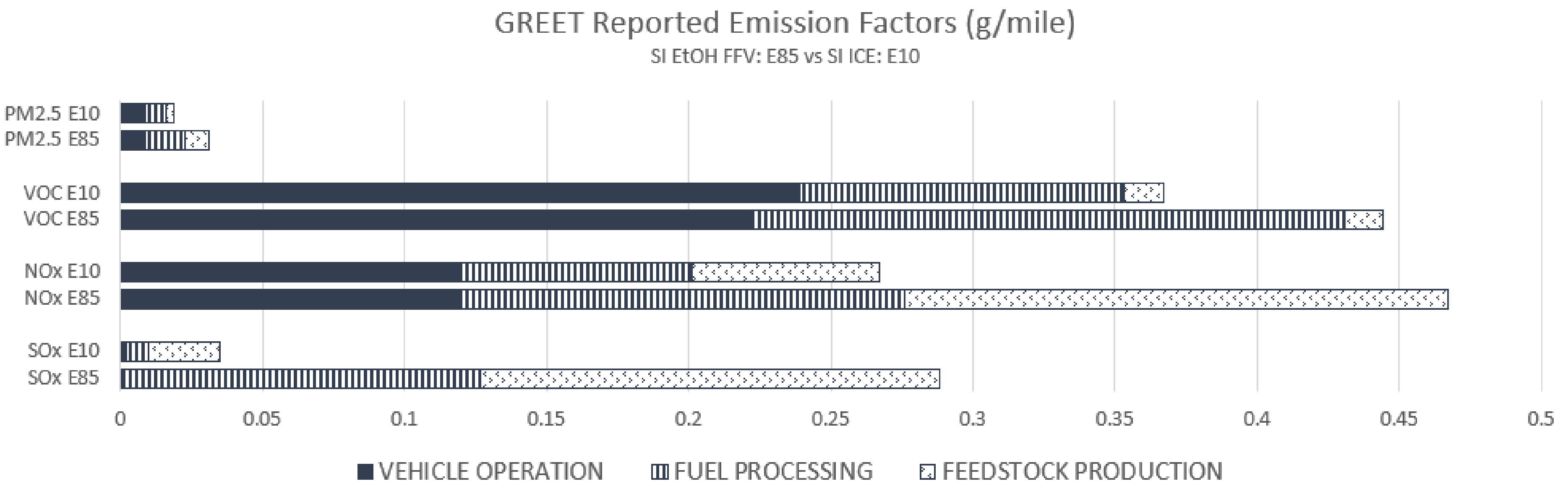

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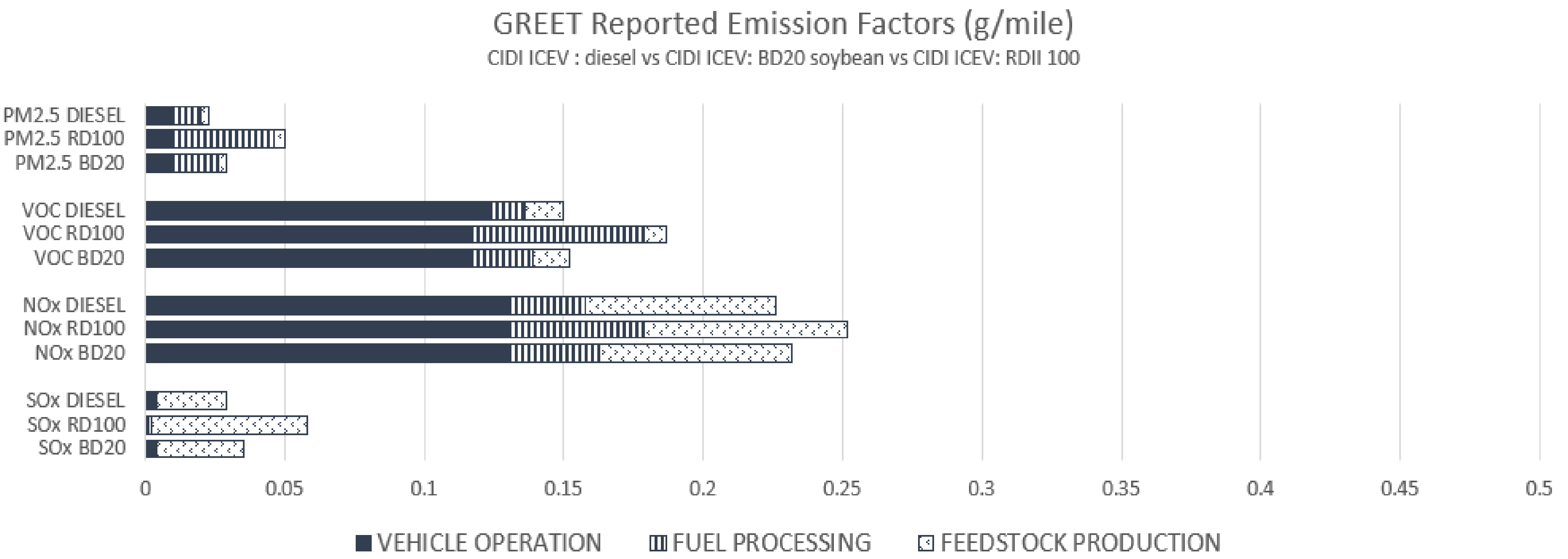

Discussion

- Ozone impacts are not considered in COBRA and could be important given significant contributions of NOx and VOC from on-road vehicles.

- Emissions from electricity generation are not included. Note that proposed MN rules would eliminate power sector emissions by 2045.

- Do GREET emission factors accurately reflect vehicle tailpipe air pollutants?
  - If yes, which approach to adjust the COBRA baseline? Note that emissions benefits may be more the result of reduced fuel consumption, more than fuel switching.
  - If no, would EPA MOVES provide a preferred vehicle fleet analysis?

- Do GREET emission factors accurately reflect fuel-cycle air pollutants?
  - To what extent would these lower or negate health benefits? If policy impact reduce tailpipe emissions nearer to population centers, a net positive health benefit may be possible, even if higher fuel-cycle emissions occur further from population centers.

References

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