



California Air Resources Board
California Environmental Protection Agency



Low Carbon Fuel Standard

Life Cycle Analysis
Working Group 1
Meeting

May 9, 2008

Meeting Agenda

- Introductions
- Presentation from University of California, Davis
- Fuel Pathways
 - Methodology of Energy and GHG Emissions Calculations
 - Overview of Completed Pathways and Carbon Intensity (CI) Values
- Discussion
- Future Fuel Pathways
- Other Stakeholder Presentations
- Lunch Break

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Fuel Pathways Well-to-Wheel (WTW) Analysis

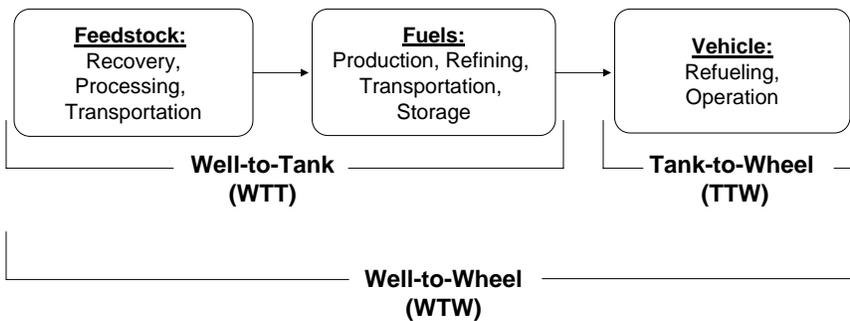
- ULSD
- CaRFG
 - CARBOB
 - Corn Ethanol
- CNG
- Electricity

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General Flowchart of Well-to-Wheel Analysis

- **WTT**: Feedstock and fuel production, transportation, and distribution
- **TTW**: Vehicle operation



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General Notes about the Pathways (1)

- Very specific scenario for each document
- GREET methodology included in all pathways
- Input values have been changed for CA where appropriate
 - crude recovery efficiency
 - electricity mix
 - etc.
- Model does NOT include vehicle adjustment factor

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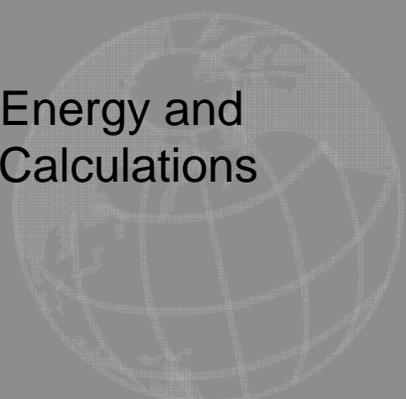
General Notes about the Pathways (2)

- Modifications made to input values could have led to values being different from AB 1007 or UC Reports
- All values preliminary at this point
- Stakeholders encouraged to review and comment

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Methodology of Energy and GHG Emissions Calculations



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Energy Calculation Methodology

- Fuel Shares: Amount of energy resource consumed during the production, transportation, processing, and distribution of a transportation fuel
- Btu/mmBtu: Calculated Btu of energy needed to produce one million Btu of the indicated fuel output
- Numbers still being refined

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GHG Emissions Calculation Methodology

- GREET includes: CO₂, CO, VOC, CH₄, and N₂O
 - CO, VOC converted to CO₂ in a short time in atmosphere
 - CH₄, N₂O are IPCC recognized GHG gases
- Carbon Intensity (CI) reported in gCO₂e/MJ
- GHG calculated in g/mile and converted to gCO₂e/MJ
 - For CO₂, CO, VOC: based on carbon content in the fuel and its density.
 - For CH₄, and N₂O: based on California Climate Action Registry (CCAR) emission factors (g/mile)

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Land Use

- Land Use (direct and indirect) not included

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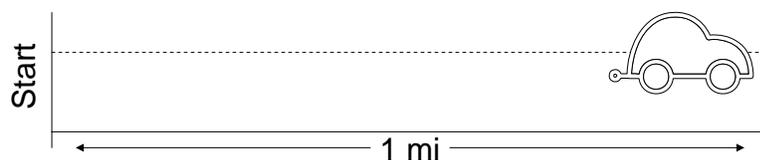
Vehicle Adjustment Factor

- LCFS will include a vehicle adjustment factor
- Recognize that some vehicles and fuel have better efficiencies
- Still determining appropriate adjustment factors

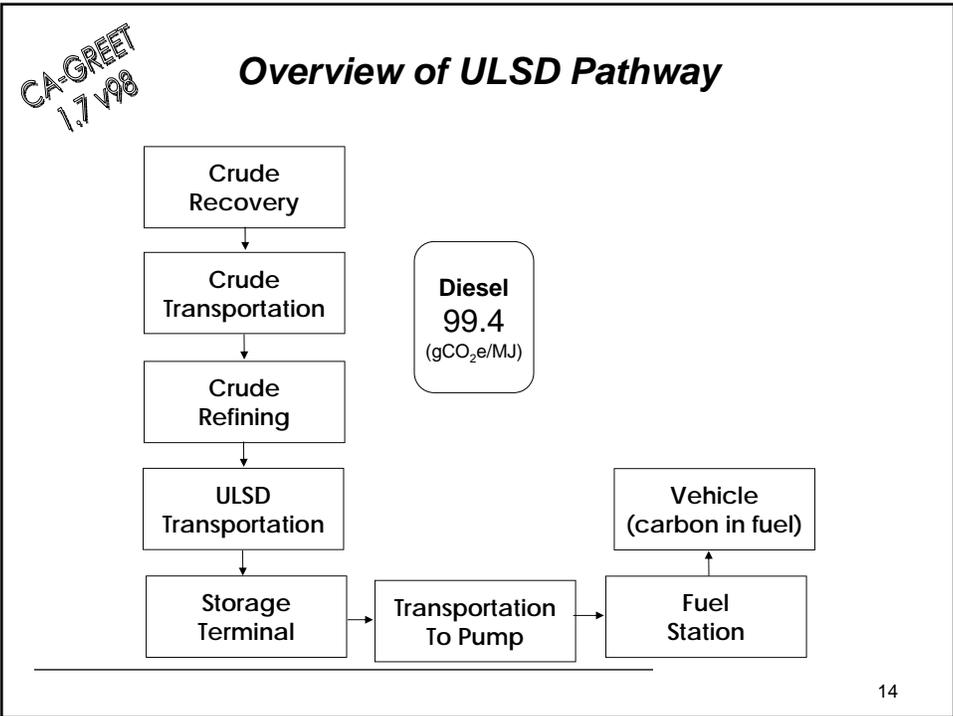
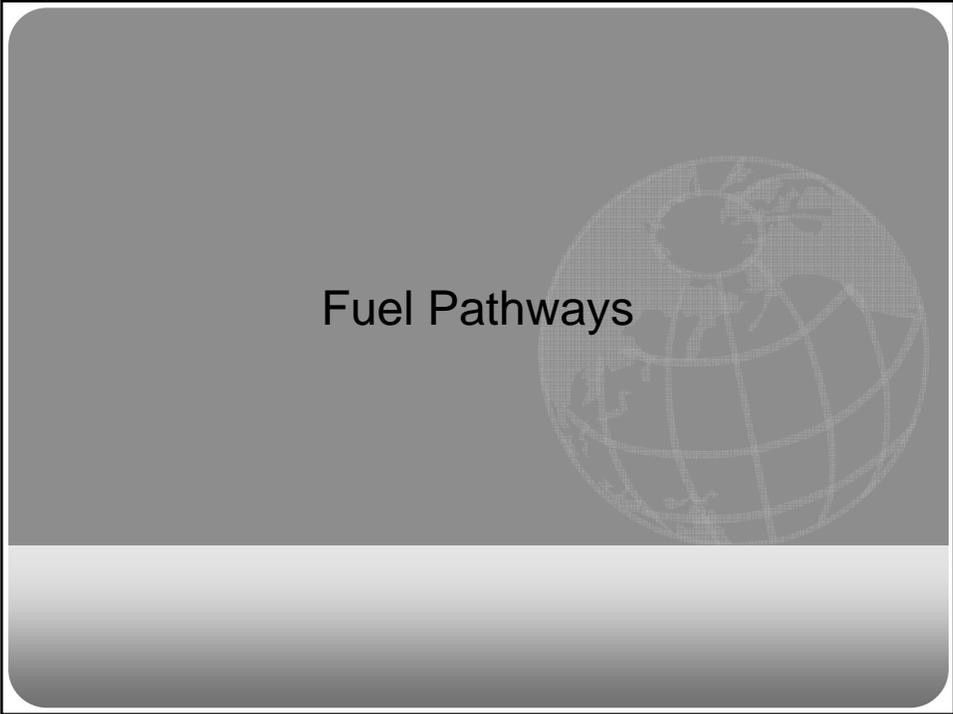
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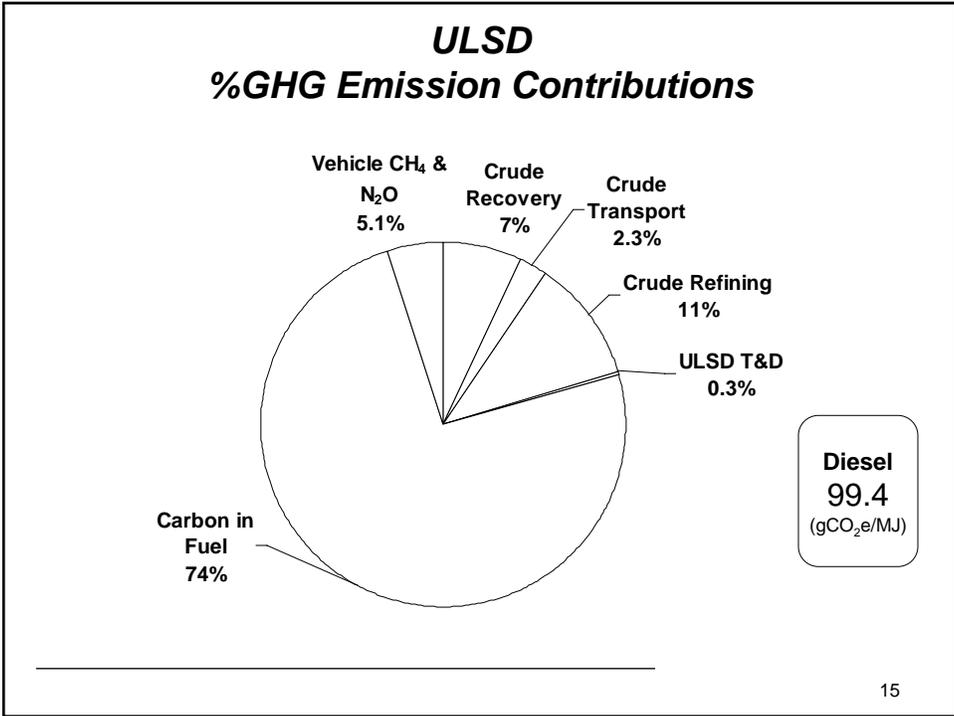
Vehicle Adjustment Factor

$$\frac{\text{Amount of energy (MJ) used per mile}}{\text{Amount of energy (MJ) a standard gasoline car uses per mile}}$$



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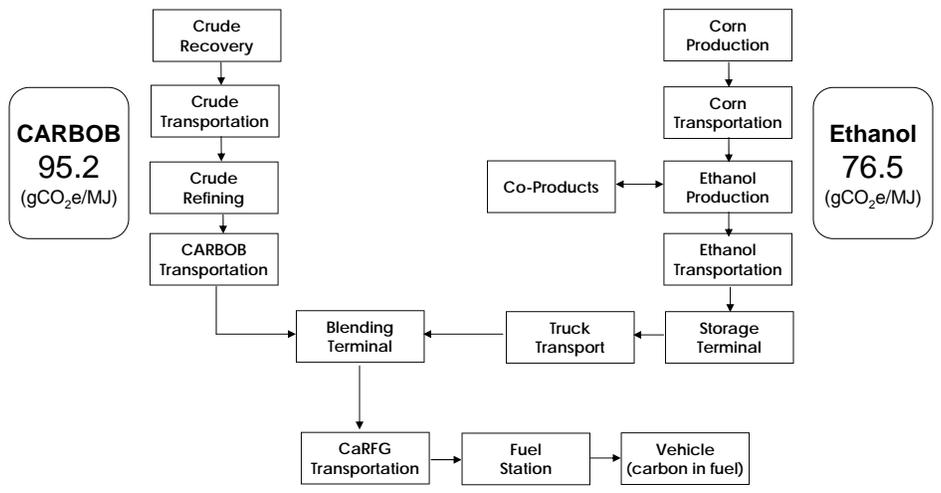


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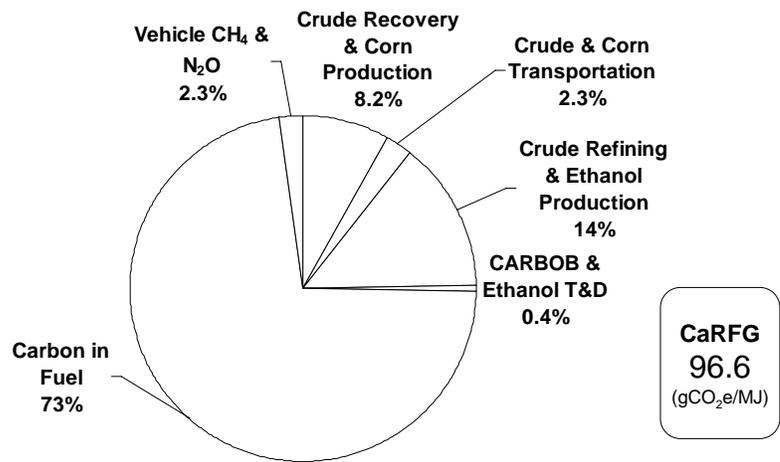
General Notes about ULSD
- Considers CA average crude mix refined in CA
 - UC reported values of CI of 91 but here CI ~99
 - Tailpipe N₂O and CH₄ included
 - Crude recovery includes CA heavy crude recovery
 - Preliminary at this point
 - To illustrate GREET embedded methodology
 - Stakeholders encouraged to review and comment
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Overview for CaRFG Pathway



CaRFG %GHG Emission Contributions

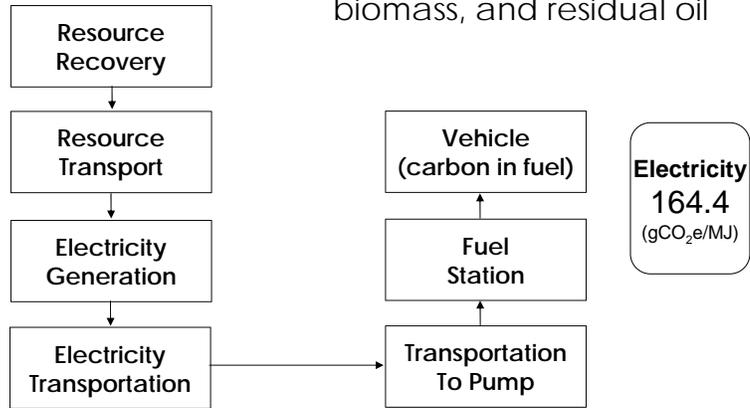


CaRFG
96.6
(gCO₂e/MJ)

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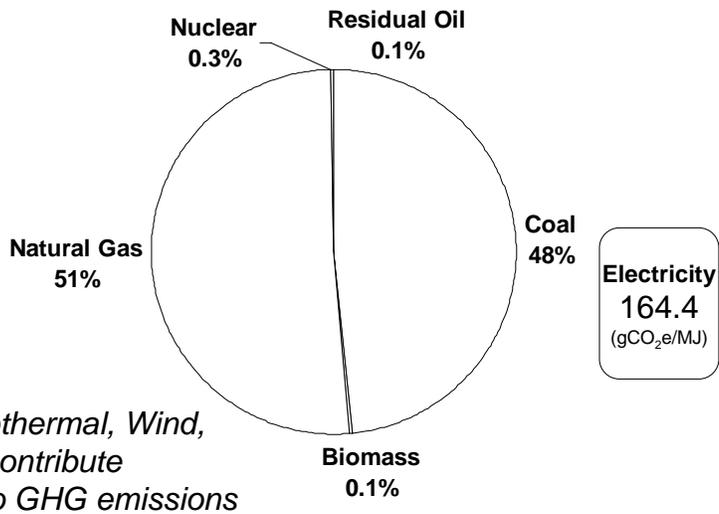
Overview for Electricity Pathway

Resources include: natural gas, coal, other (includes wind, hydro, etc.) uranium, biomass, and residual oil



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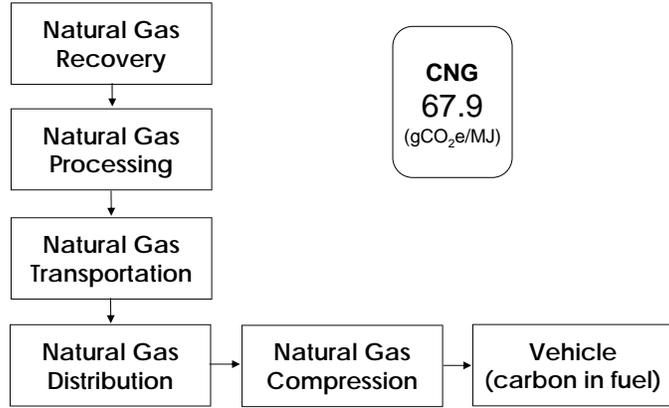
Electricity Production %GHG Emission Contributions



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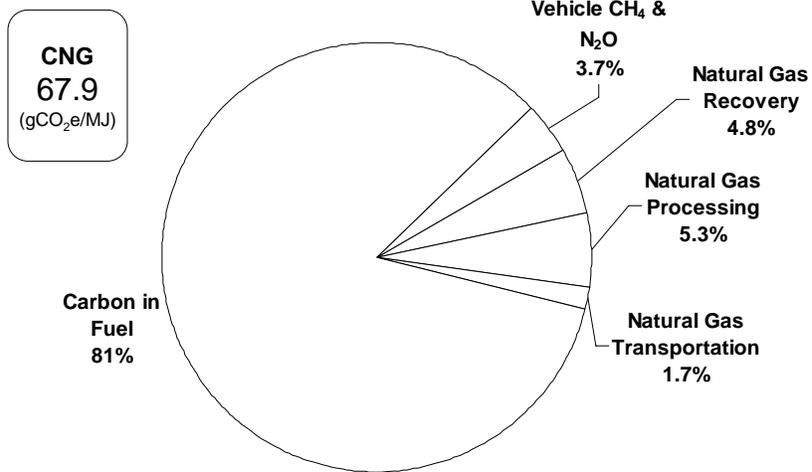
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Overview for CNG



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CNG %GHG Emission Contributions



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Future Pathways

- Biodiesel
- LNG
- Cellulosic Ethanol
- Hydrogen
- Renewable Diesel
- Propane
- Bio-methane
- Coal-to-Liquid
- Gas-to-Liquid
- Oil Sands

Others?

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Future Work on Pathways

- Review stakeholder comments and update if necessary
- Incorporate aspects of GREET 1.8b into CA version
- Provide updated CA-GREET model
- Review current input values and update if appropriate
- Detail additional pathways as needed

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Tentative Working Group Meeting

- Next Lifecycle Analysis Working Group Meeting

Proposed: June 16, 2008

See LCFS website for details