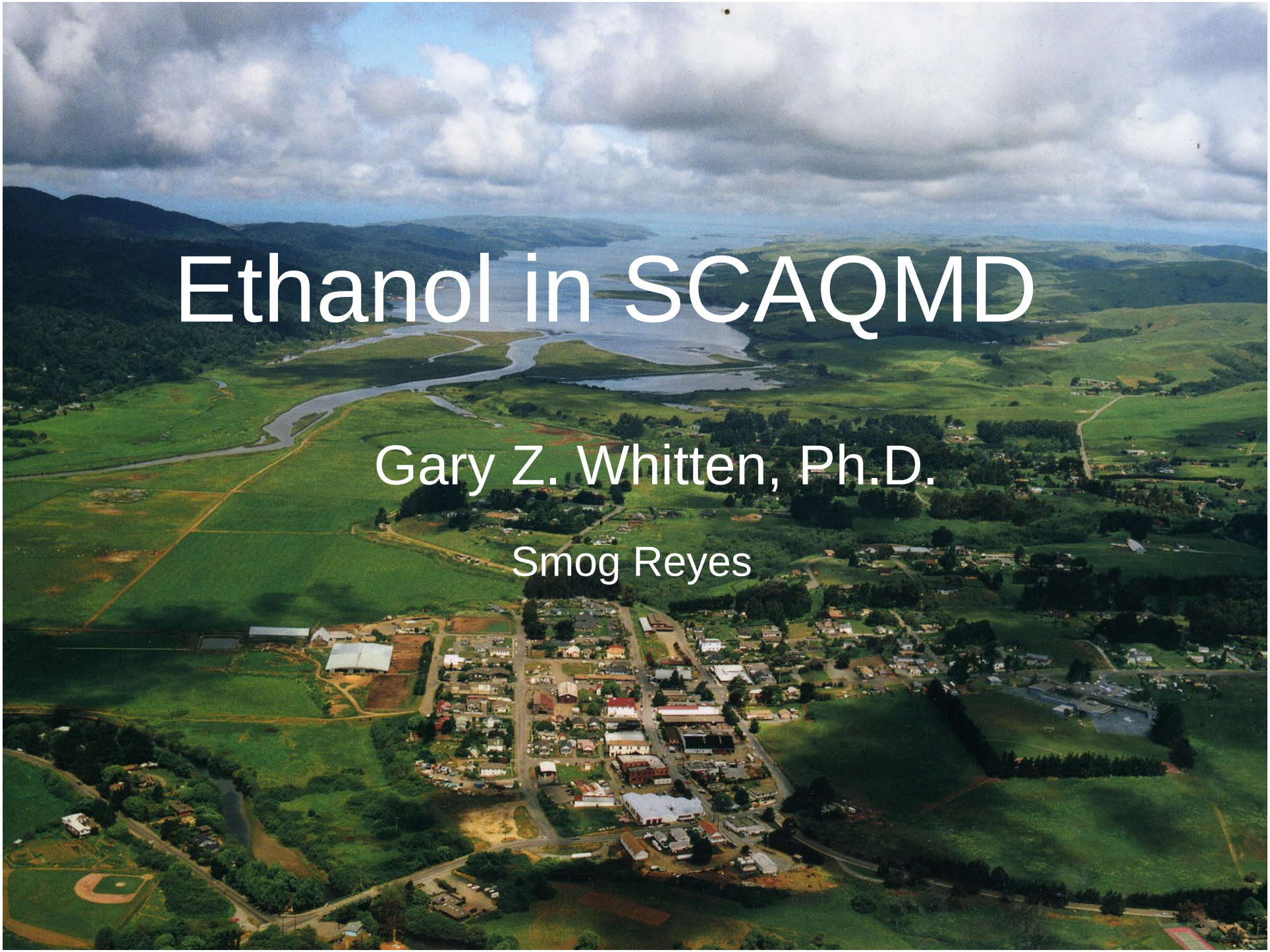

Ethanol in SCAQMD

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Smog Reyes

Ethanol in SCAQMD

- Three Key Points:
  - E6 or E10 to be ozone neutral onroad
  - E10 gives nonroad and PM benefits
  - E85 big NOx benefit

E10 Should be best

- Without NOx increase, easiest for refiners.
- At about the same volume MTBE and ethanol have similar properties
  - Octane
  - T50
  - Dilution
- Ethanol does bring more volatility and permeation, but it has more oxygen, that gives more CO and HC reductions
- Thus, E6 loses on fuel volume, octane, T50, dilution, volatility, and permeation, without any extra oxygen to compensate for volatility & perm.

New Predictive Model Should have less NOx Increases

- Current PM increases NOx 4.6% for E10 versus MTBE11.
  - Refiners can't compensate for so much NOx..
  - Need 1 or 2 ppm S and 1 or 2% olefins.
- Remote data and EMFAC consistent with 80% NOx from 20% of vehicles.
- But 80% of PM database from lowest 20%

New Predictive Model Should have less NOx Increases

- Current status:
  - Apparent agreement on best statistics for Tech 4 database giving much less NOx increase.
  - Proper handling of Tech 5 data now under discussion.

CO Reduction Should Offset Permeation

- Not resolved yet, but four factors involved:
  - Extent of permeation
  - Amount of CO emitted relative to VOC
  - Reduction percentage from fuel oxygen
  - Reactivity of CO relative to VOC

Reactivity of CO relative to VOC

- European reactivity ratio about 10 to 1.
- EPA has reported 15 to 1.
- MIR predicts 59 to 1 (48 to 1 in PM).
- New ARB study 39 to 1 based on SIP grid model instead of high-NOx box-model used for MIR's.

Current CO Offset Too Low

- Below 2% oxygen no VOC debits are charged for CO increases (due to ethanol permeation).
- CO reactivity factor used in PM is 48 to 1.
- ARB (based on EMFAC) claims E5.7 lowers CO 7.8 grams per day per vehicle.
  - Thus, 1.1 g. permeation can not be compensated by 7.8 grams CO at 48 to 1 reactivity.

Current Offset Questionable

- Statewide EMFAC shows 23.9 million gasoline vehicles.
  - 7.8 grams per vehicle then 169 tons per day.
- Statewide ARB gasoline on-road CO inventory is 7243 tons per day (2005 summer).
- This implies less than 1.2% CO reduction per percent oxygen in fuel (below 2% Ox)
- Above 2% fuel Ox PM uses 5.9%
  - And even this assumes zero impact Tech 5.
  - Using recent data for Tech 5 raises 5.9% to 9%.

Current Offset Questionable

- Current offset is 7.8 grams CO available, but this is based on only 1.2% CO reduction.
  - 1.2% assumes non-oxy adjustments with low sulfur and T50, plus lack of data on aggressive driving.
  - Yet available non-oxy fuel data do not support low sulfur and T50 (have low RVP instead).
- Using 9% gives 60 gram CO offset.

10 Percent Ethanol

- Significant reductions from THC, CO, PM
  - Current Predictive Model 3% less HC exhaust
    - With attention to higher emitters: 5% less
  - Non-road reductions in CO, THC (22%CO, & 12%[4-cycle]THC vs. non-oxy)
    - No other fuel formulation can do this!
  - Colorado, UK studies show up to 50% less fine organic particulates ($PM_{0.5}$)
    - Some scientists believe organic fines important.

E85 Major NOx Reductions

- While THC can meet certification requirements with proper adjustments, NOx reductions of 40% are typical.
  - Apparently explained by lower combustion temperature of ethanol relative to gasoline.