Control of Emissions from Biogas Engines: Successes and Challenges

OCACS Environmental Group Bimonthly Presentation

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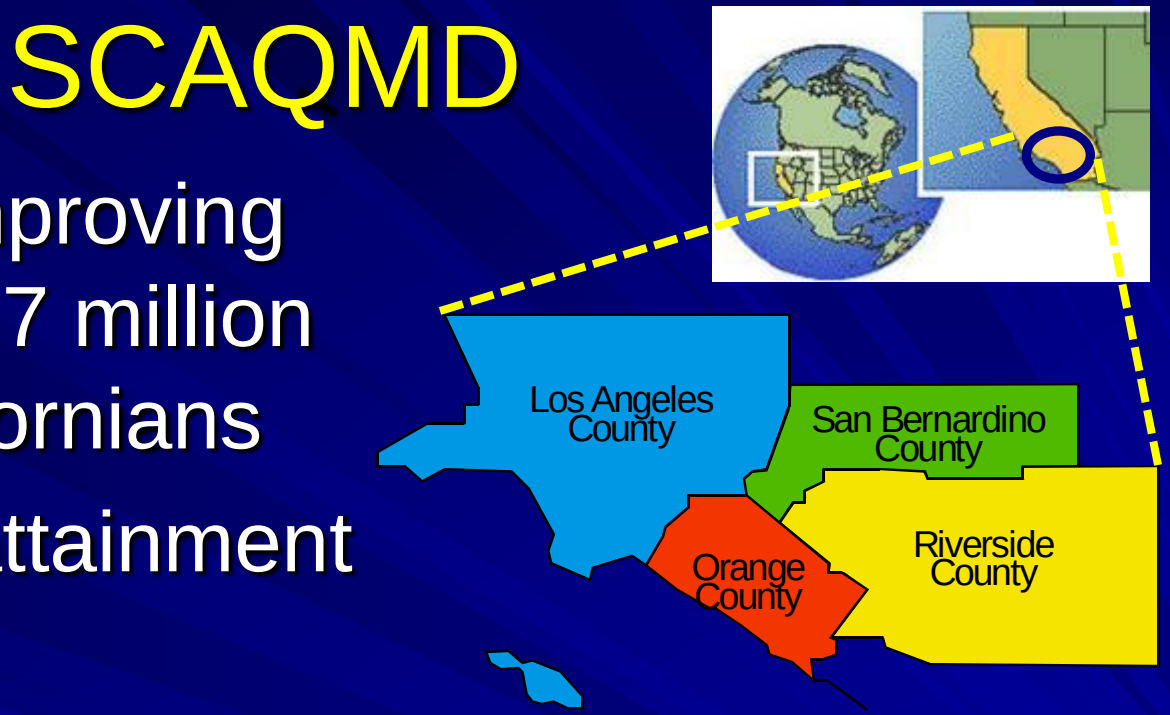
Rule 1110.2 Biogas Engine Amendment

- Amended on September 7, 2012
- Effective date of January 1, 2016
- Lowered limits of biogas engines to
  - 11 ppmv NOx
  - 30 ppmv VOC
  - 250 ppmv CO
- Previous limits were
  - 36 or 45 ppmv NOx, depending on size
  - 40 ppmv VOC (landfill), 250 ppmv (digester)
  - 2000 ppmv CO

Rule 1110.2 Biogas Engine Amendment

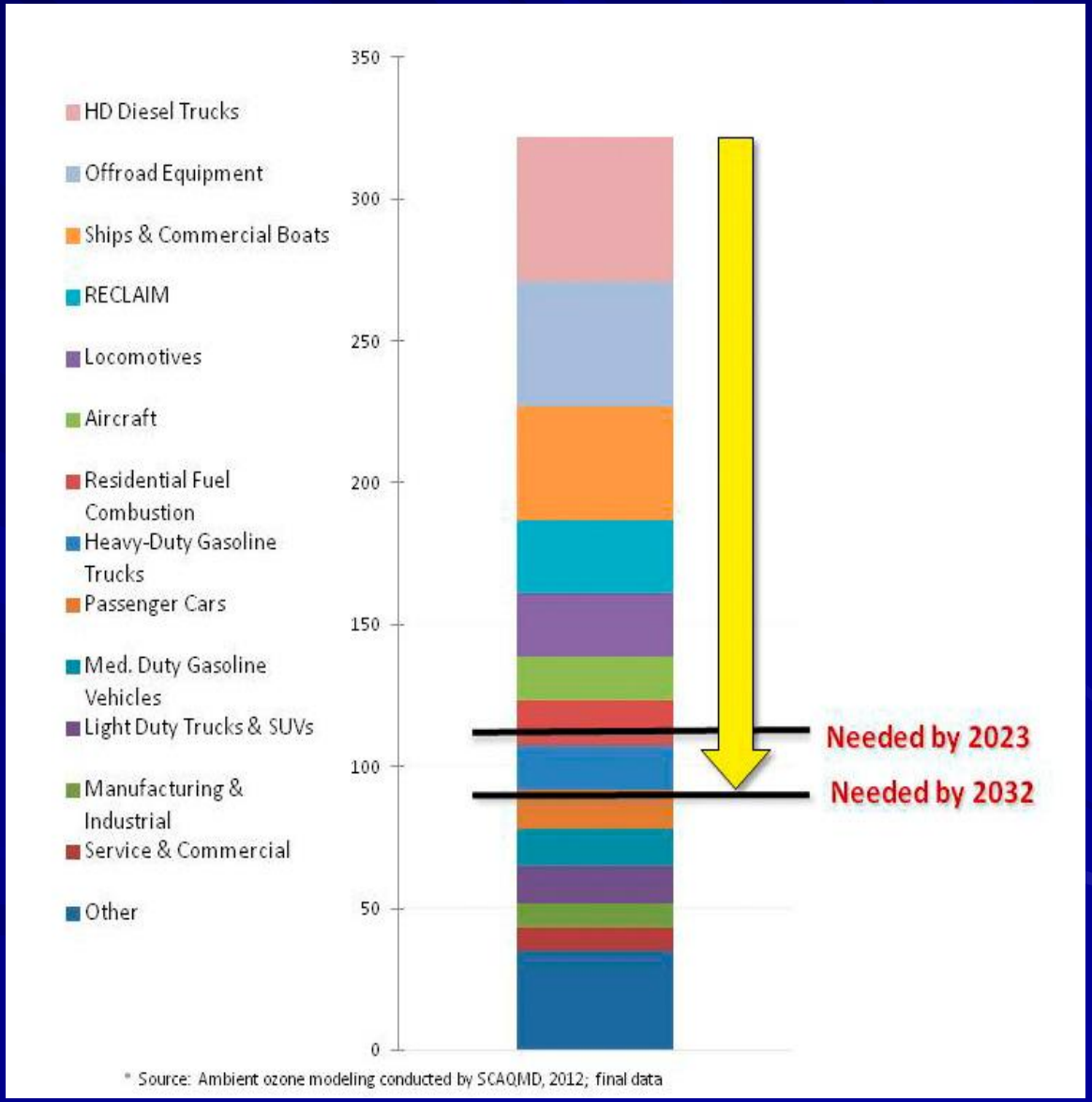
- Important component of attainment strategy
- Multi-pollutant reduction benefit
- Toxic pollutant reduction co-benefit
- Compliance schedule allows exploration of other feasible technologies

SCAQMD



- In charge of improving air quality for 17 million Southern Californians
- Extreme non-attainment for ozone
- Non-attainment for $PM_{2.5}$ (both annual and 24-hr average standard)
- Significant progress made in improving air quality, but
- Much more needed for attainment

Emissions Reductions to Meet Ozone Standards



R1110.2 Emission Reductions from Biogas Engines

- NOx: 334 tons per year
- VOC: 178 tons per year
- CO: 7,302 tons per year

Biogas Engines

- Internal Combustion Engines (ICEs) fueled by digester gas or landfill gas (Biogas)
- Operated by many landfills and wastewater treatment plants to produce power

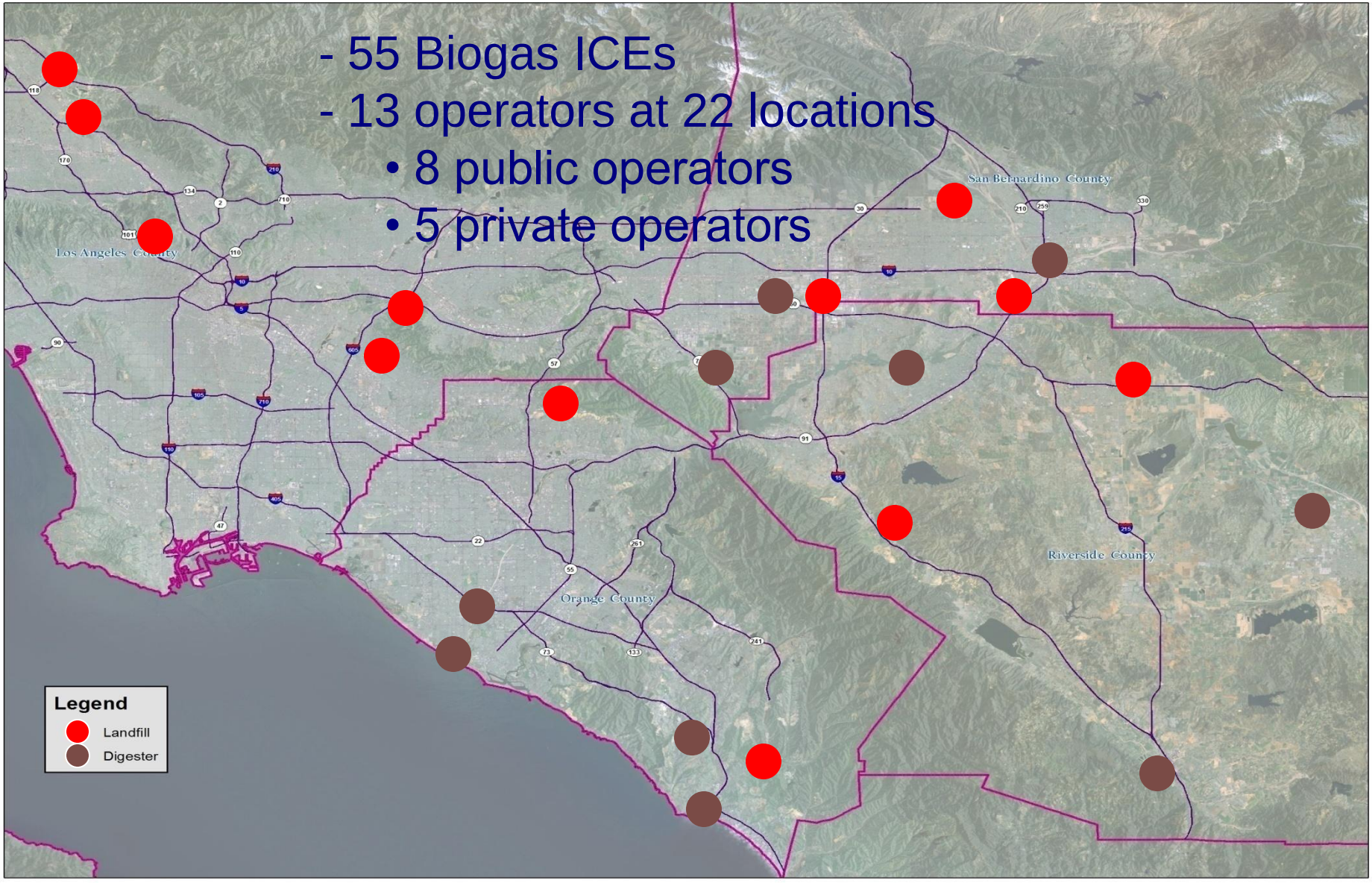
- Biogas is considered a renewable source of energy, **but**
- Power produced by Biogas engines is significantly dirtier than that of central power plants
- Rule 1110.2 limits Biogas engine emissions

Biogas Engines

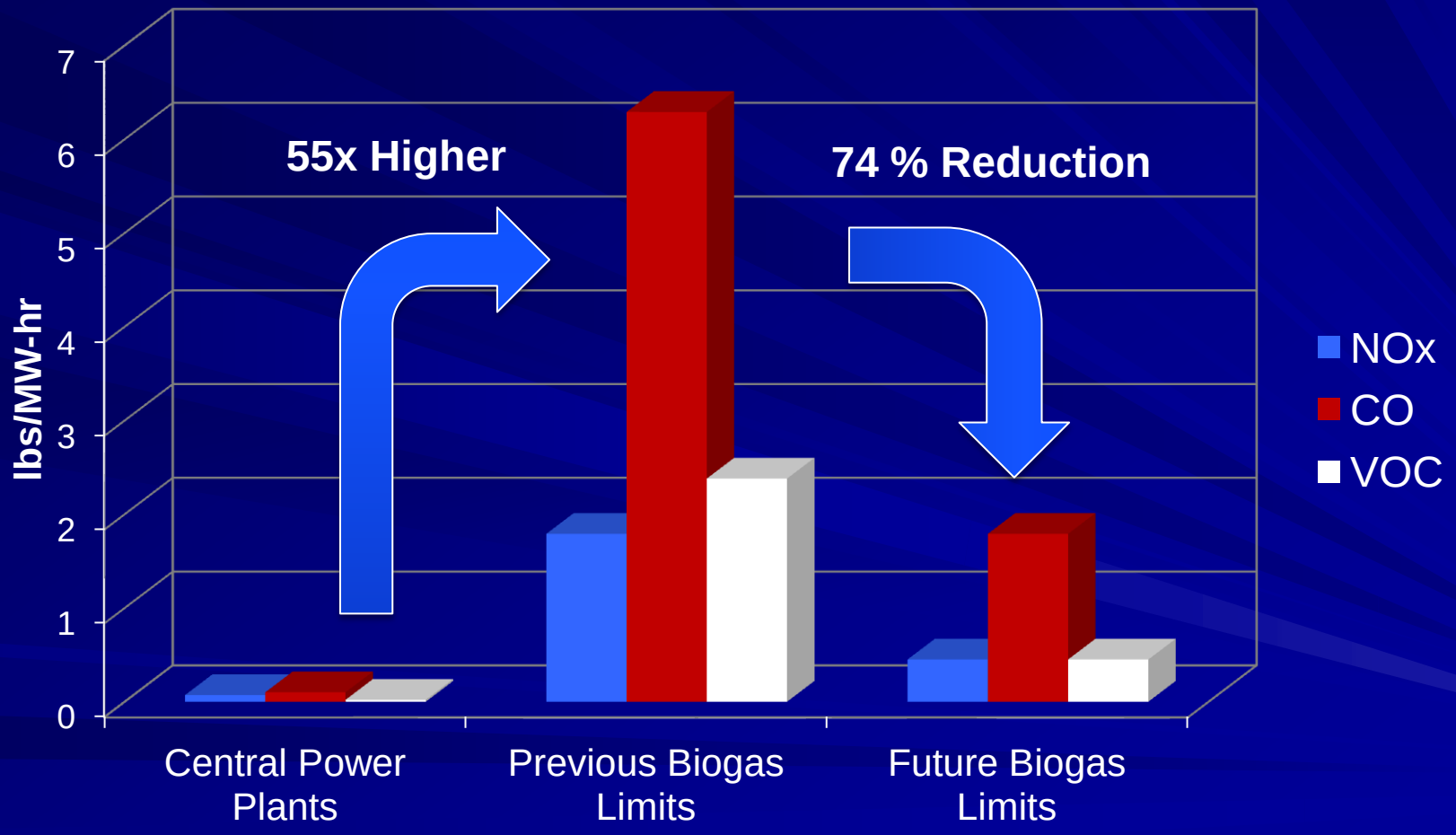
- Harness a renewable energy source

- Significant emissions footprint
  - Precursors to $PM_{2.5}$ and ozone

Biogas Engines in the Basin

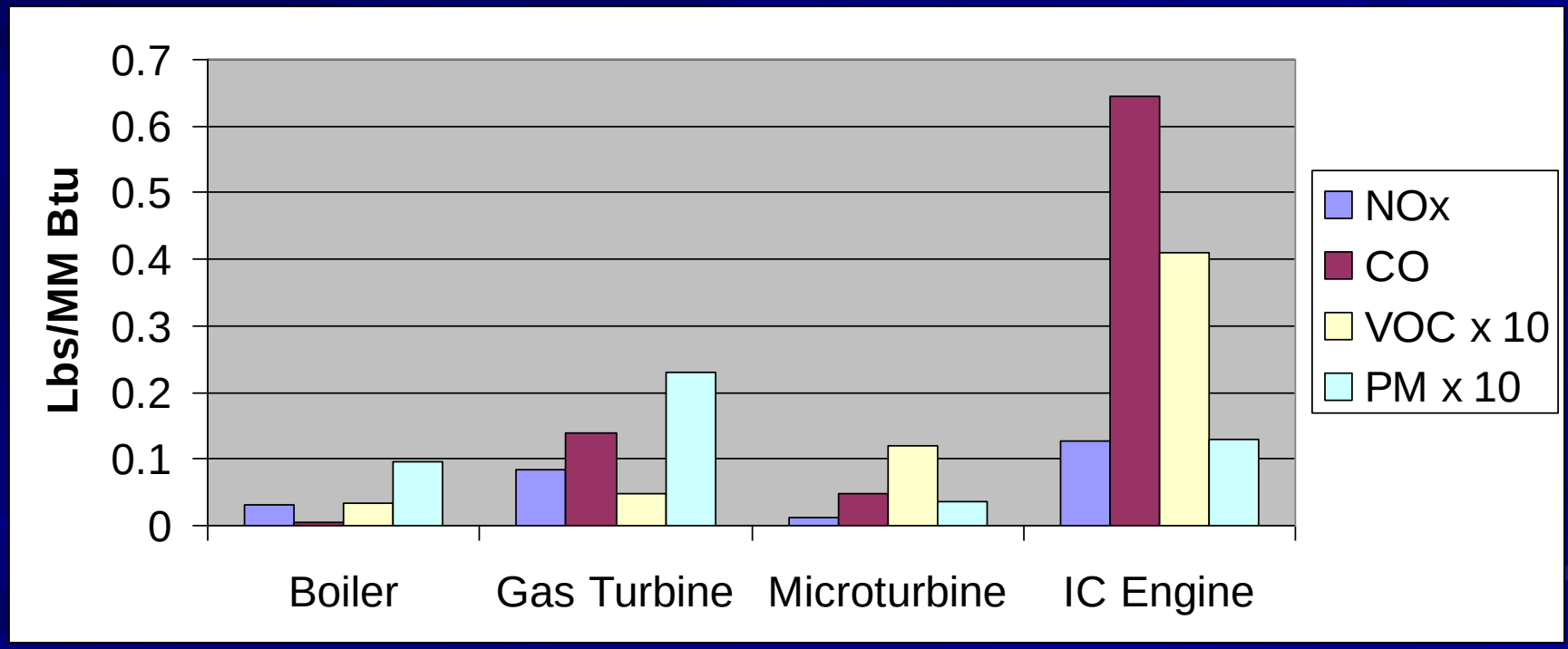


Power by Biogas ICEs vs. Central Power Plants



*Previous Biogas CO value divided by 7

Emissions Comparison Among Biogas Electrical Generation Technologies



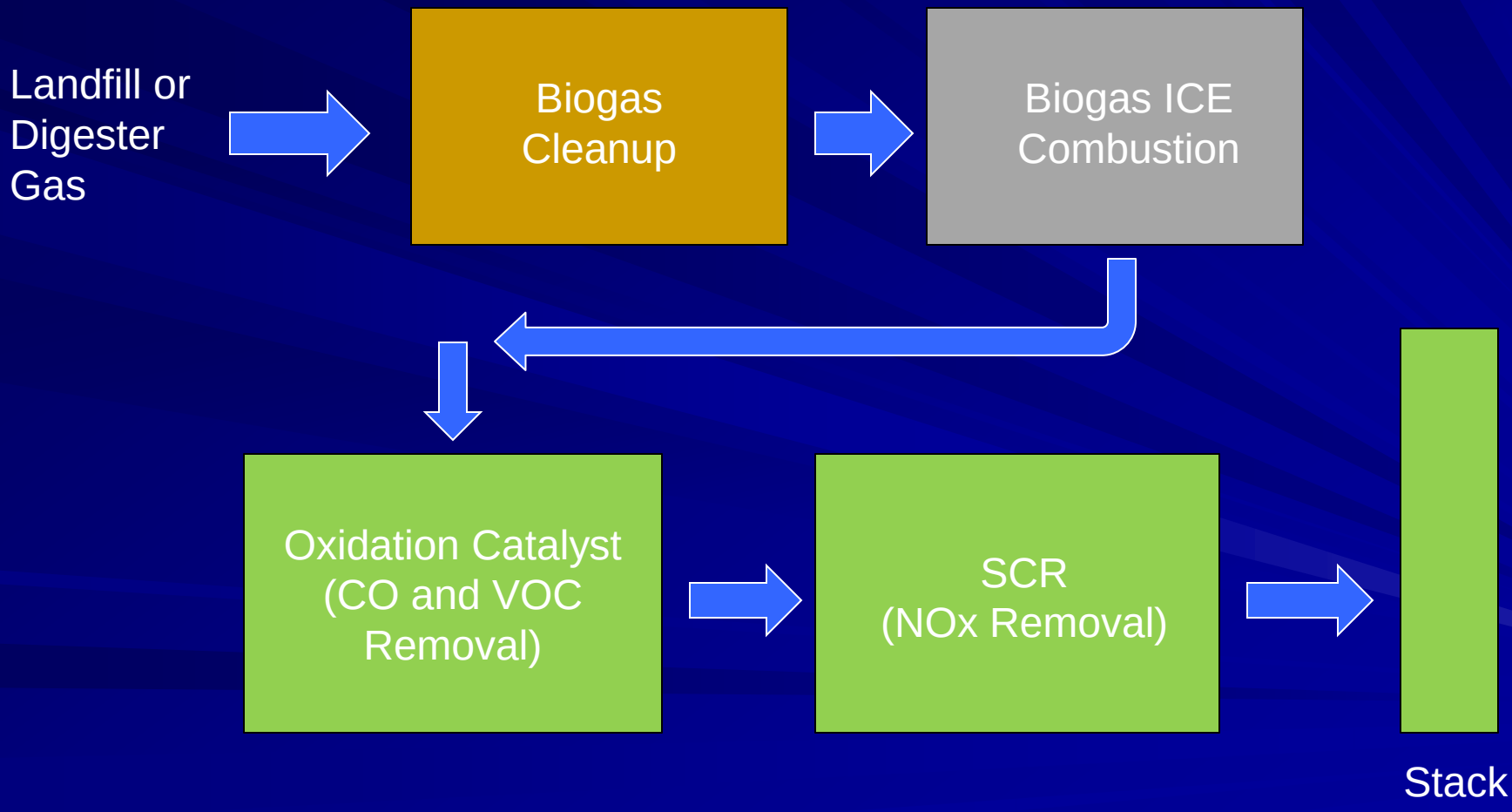
Production of Biogas

- Wastewater Treatment Plants
  - Anaerobic digesters create biogas as a product of sewage treatment
- Landfills
  - Biogas is a product of the decomposition of municipal waste

Use of Biogas

- Wastewater Treatment Plants
  - Combust biogas to create in-house power
  - Also used for heat recovery
- Landfills
  - Combust biogas to create power which can be sold to the grid

Biogas Process Flow



Catalyst Technologies

- Oxidation Catalyst/Catalytic Oxidizer
  - Hydrocarbons and Carbon Monoxide are oxidized to produce carbon dioxide and water
- Selective Catalytic Reduction (SCR)
  - Oxides of Nitrogen (NOx) are reduced in the presence of a reducing agent and a catalyst to produce nitrogen gas and water

SCR Installations (OCSD)

Gas Cleanup System

Oxidation Catalyst/SCR on elevated platform

Fountain Valley facility engines

SCR Installations (Ox Mountain)

Gas Cleanup System

SCR system

Engine exhausts at Ox Mountain

Technology Assessment

- Focused on:
  - Projects co-sponsored by AQMD
    - Biogas Cleanup/Catalytic Oxidation/SCR Technology
      - Orange County Sanitation District (OCSD)
    - NOxTech (Non-Catalytic Combustion)
      - Eastern Municipal Water District (EMWD)
  - Other relevant projects
    - Ox Mountain Landfill in Bay Area
      (Biogas Cleanup/Oxidation Catalyst/SCR)
  - Alternative Technologies to ICEs

Technology Assessment

- Orange County Sanitation District Pilot Study
  - 1 year study used oxidation catalyst/SCR technology with biogas cleanup
  - Partially funded by AQMD
  - Completed in March 2011
  - Cost effectiveness: $1,600/ton
  - Average pollutant concentration
    - NOx 7.2 ppmv (35% below 11 ppmv)
    - VOC 3.6 ppmv (88% below 30 ppmv)
    - CO 7.5 ppmv (97% below 250 ppmv)
  - Occasional spikes above 11 ppmv limit (<1% of valid data)

Technology Assessment

- NOxTech
  - Installed at EMWD Mills site with natural gas engines (in 2010)
  - No gas clean up necessary
  - Exhaust Gas Recirculation (EGR) installed to handle higher temperatures associated with natural gas combustion
  - Preliminary data showed achievability of proposed limits

Technology Assessment

- Ongoing demonstration projects point to other viable technologies as well as alternative technologies to ICEs
  - Flex Energy
  - Fuel Cells
  - Turbines
  - Hydrogen Injection
  - Boilers

Fuel Cell Energy 2.8 MW unit

Flex Energy FP250 system

Ox Mountain Project – Bay Area

- Landfill gas control system
  - Gas cleanup/oxidation catalyst/SCR in operation for over 26,000 hours (almost 3 years)
  - District Staff visited facility on April 24, 2012
  - Oxidation Catalysts for 6 engines have effectively removed VOC and CO throughout duration of project
  - SCR catalyst has been effectively removing NOx

  - TSA gas cleanup system has effectively removed siloxanes throughout project duration
    - No siloxane breakthrough

Ox Mountain Project – Bay Area

- Ox Mountain
  - Some issues/challenges during start-up/optimization phase, smooth performance subsequently
  - CO catalysts have experienced an elevation in emissions
    - Engine wear is suspected as the cause
    - Results still compliant with proposed emission standard
  - CEMS analyzer readings during site visit
    - 8.3 ppmv NOx @15% O_2
    - 74.3 ppmv CO @15% O_2

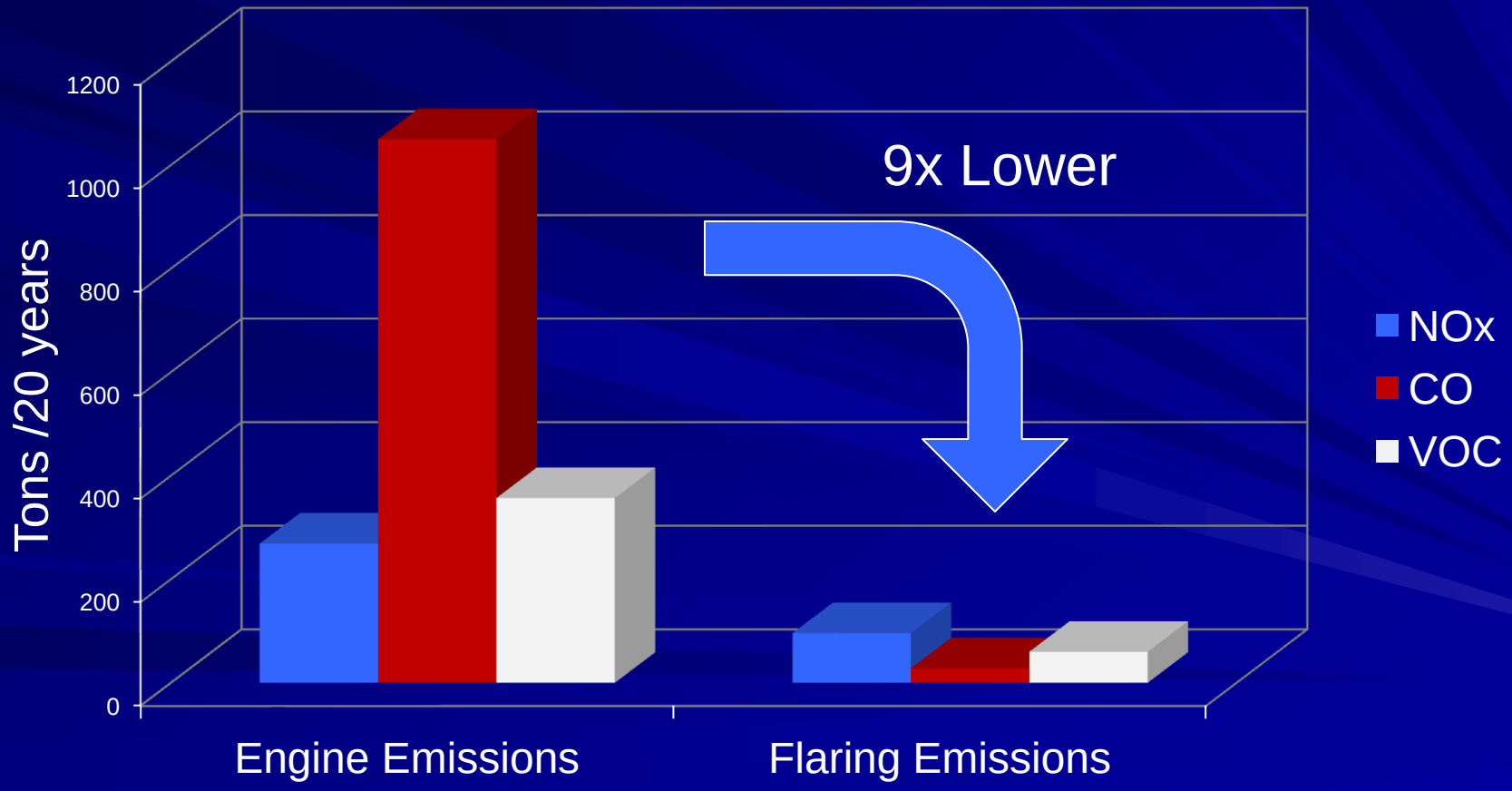
GHG Impacts

- Evaluated impacts of flaring/purchasing electricity from central power plants in the event ICEs are discontinued
- Criteria pollutant/GHG trade-off
  - Flaring has a lower criteria pollutant profile than that of ICEs
  - However, there are some GHG Impacts

- The CO_2 emissions are not significant

ICE vs. Flaring Emissions

- Aggregate emissions normalized for a 2,500 kW engine operating 6,000 hours per year for 20 years



ICE vs. Flaring Emissions

- Flaring, though undesirable, results in less criteria pollutant emissions. The increase in GHG emissions is not significant

Pollutant	Magnitude of Flaring w/BACT Flare + Baseload Compared to ICEs
NOx	5 to 7x Less
CO	67x Less
VOC	4 to 27x Less
GHG (CO_2e)	1.4x More

Key Issues

1. *Time for Implementation*. Stakeholders are requesting an effective date of July 1, 2017 to comply with the requirements of the rule.

   Response:

   - Staff proposal – January 1, 2016
   - Staff proposal provides reasonable additional time for the completion of on-going projects and the stakeholders' decision making process for selecting the right control technology for their site.
   - For those facilities that entered into long term power purchase agreements prior to the February 1, 2008 amendments:
     - -An alternate compliance option deferring compliance up to two years from the effective date.
     - -Payment of a compliance flexibility fee provided such contracts do not expire prior to the January 1, 2016 effective date.

Key Issues

2. Cost of Compliance. Stakeholders have commented that the capital and operating costs for cleaning up the biogas are very high and post-combustion control technologies such as Catalytic Oxidation and Selective Catalytic Reduction (SCR) are expensive to install and operate and argued that many of them will resort to flaring as a less costly alternative.

Response:

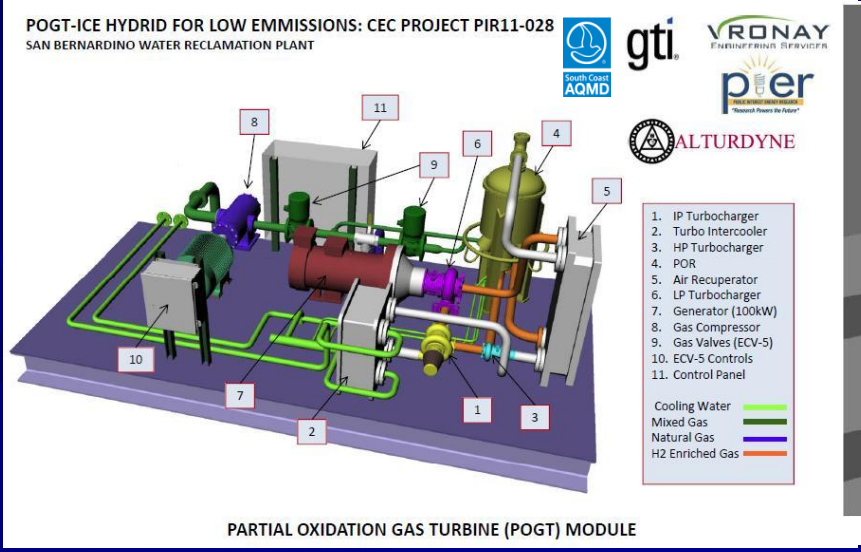
- The costs are significant but the environmental benefits are also significant.
- Proposed controls are very cost effective.
- Reasonable emission reductions such as those from biogas engines needed to meet the ambient air quality standards.
- Flaring of a renewable energy source is undesirable.
- Biogas flaring, except for a small Greenhouse Gas disbenefit, has a much lower criteria pollutant footprint compared to biogas engines, even considering power that needs to be generated by central power plants.

Ongoing Implementation Commitments

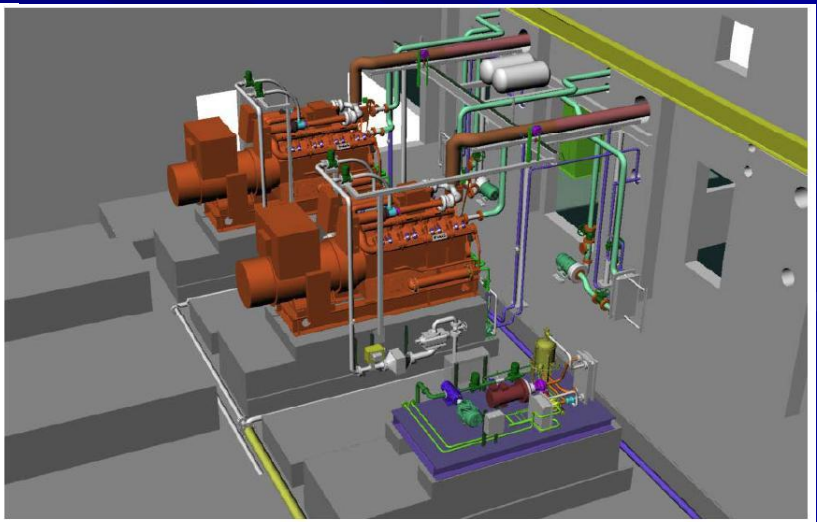
- Governing Board Resolution
  - Committed to reporting on the status of on-going demonstration and other commercial biogas control technology projects to the Governing Board Stationary Source Committee beginning no later than July 1, 2013, and at least annually thereafter

Projects

- Contract with Gas Technology Institute (GTI) for demonstration of H_2 assisted lean operation emission control technology on a biogas engine at San Bernardino Water Reclamation Plant
- Expected on-line July/August 2014



PARTIAL OXIDATION GAS TURBINE (POGT) MODULE


POGT MODULE SKID LOCATION

Projects

- Contract with GTI to conduct a nationwide survey of biogas cleanup technologies and develop toolkit to estimate biogas cleanup costs
- Final report and toolkit completion by July 2014
- Alpha-Toolkit made available to stakeholders



Activities

- Eastern Municipal Water District NOxTech exhaust control system
  - NOxTech system installed at EMWD's Mills Pumping Plant
  - SCAQMD contract for demo at EMWD's Temecula water treatment plant expected on-line June 2014

- Orange County Sanitation District
  - Retrofitted 2.5 MW (3,471 bhp) ICE with gas clean-up & SCR/Oxidation catalyst emission control
  - Retrofit of remaining seven biogas ICEs

Other Activities

- Ameresco installation at Ox Mountain Landfill, Half Moon Bay (BAAQMD)
  - Gas clean-up & SCR/Oxidation catalyst
  - Permit finalized on February 7, 2013
  - NOx limit set at 0.15 g/bhp-hr (11 ppm)
  - CO limit set at 1.8 g/bhp-hr (225 ppm)

- SCAQMD continued collaboration with EPA Region 9 California Biogas Wastewater Workgroup
  - Case studies, emerging technologies, policy developments, and funding opportunities

More information

- http://www.aqmd.gov/home/governing-board/agendas-minutes
  - Scroll down to September 7, 2012 Agenda link and click to download pdf of board package
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