



Biochar

Greenhouse Gas Offset Protocol

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Forest Management Greenhouse Gas Offset Protocols

1. Biomass waste for energy

- Reduce methane from open pile burn or in-field decay/decomposition
- Avoided fossil fuel for equivalent electricity

2. Biochar

- Sequester carbon in stable biochar

3. Black carbon

- Reduce black carbon from open pile burn

4. Forest hazardous fuel reduction thinning treatments

- Reduce wildfire severity and size
- Reduce tree mortality
- Stimulate forest growth
- Wood products, biomass energy





CAPCOA Greenhouse Gas Exchange

- Launched in February 2014
- Joint effort of Bay Area AQMD, Placer County APCD, Sacramento Metro AQMD, South Coast AQMD, San Joaquin Valley APCD, and Northern Sonoma APCD
- Provide California-based Greenhouse Gas Credits
 - Secure, transparent, and low-transaction cost exchange
 - Local jobs, air pollution co-benefits
- Responds to request from local governments and private industry for credits for compliance with CEQA, climate action plans, and other voluntary purposes
- Protocols – biomass-for-energy, boiler efficiency, livestock manure, forest management, case-by-case



Biochar Protocol

- Biochar -- porous, carbon-rich, charcoal -like solid
- Formed from the thermal pyrolysis / gasification of biomass
- Use as soil amendment:
 - Sequesters carbon -- highly stable and resistant to decomposition
 - Enhances soil fertility -- increases water and nutrient holding capacity
 - Reduces soil emissions, enhances biomass growth
 - Displaces fertilizer manufacturing
- Also produces renewable energy





Biochar Protocol

**Prasino Group,
The Climate Trust,
International Biochar Initiative**

California forest
and ag woody
biomass that
would have been
open burned

All/any
Biomass

2012 –
Nov 2014



Carbon sequestration
GHG offset protocol



Dec
2014

Water retention
Fertilizer displacement
Plant growth



Planning
with Cal
Dept. of
Food & Ag



Biochar Protocol

- Protocol review and approval process
 - Draft completed -- September 2014
 - Stakeholder webinar – September 9, 2014
 - 30 day public review close – October 9, 2014
 - CAPCOA Engineering Protocol Review Committee -- November
 - CAPCOA Board Approval -- December
- <http://www.placer.ca.gov/departments/air/apc/dbiomass>



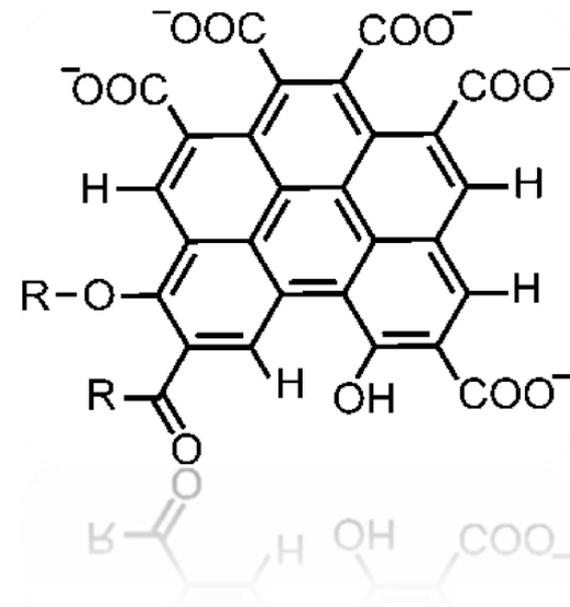
Biochar Protocol

- Location -- Biochar production project operations that are located within the state of California, including source of feedstock.
- Feedstock
 - Biomass waste byproduct.
 - Production operations must protect or enhance long-term productivity of the site by maintaining or improving soil productivity, water quality, wildlife habitat, and biodiversity where the biomass originated.
 - Harvesting of material must meet regulations from the National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA), California Forest Practices Rules and Regulations, and/or Timber Harvest Plans.
- Baseline
 - Open pile burned, decay in field, used for energy
 - Economic test, regional common practice
- Biochar
 - IBI Standardized Product Definition and Product Testing Guidelines for Biochar that is used in soil.
 - $H/C_{org} < 0.7$
 - Land applied or mixed with soil, compost, or medium intended as a soil amendment.



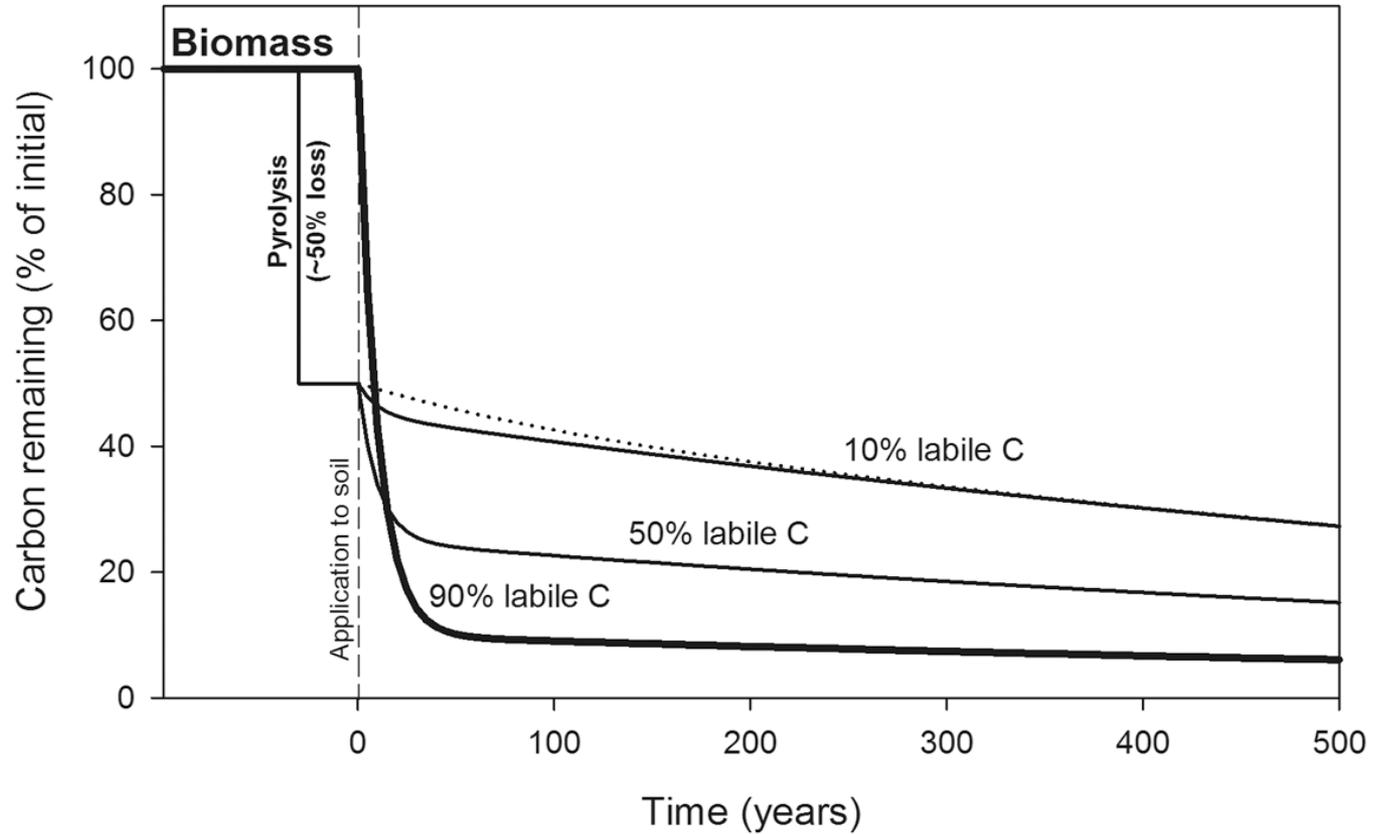
Biochar Stability

- **Fused aromatic carbon rings** → material property most likely responsible for biochar





Biochar Stability

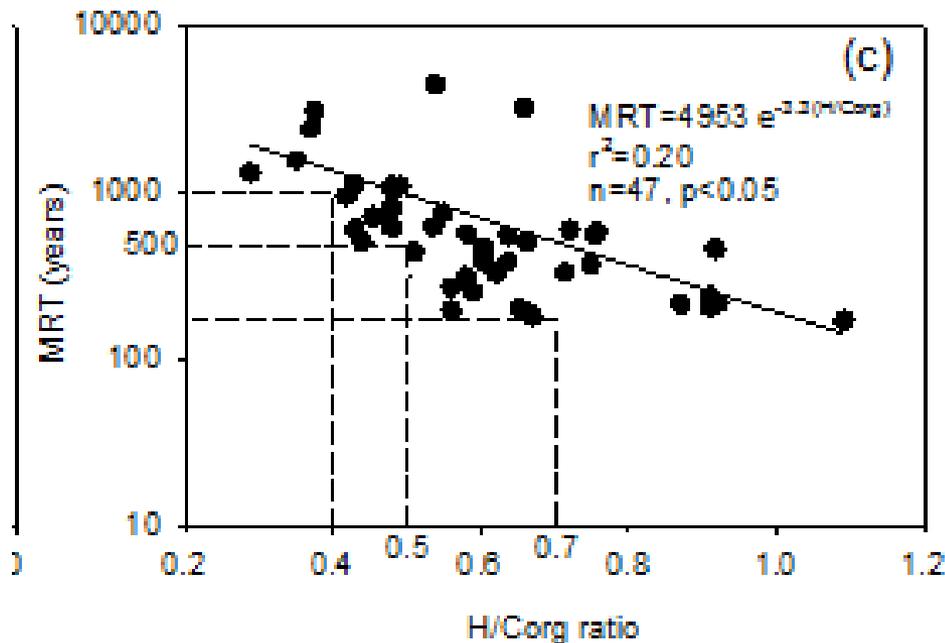




Biochar Stability

Hydrogen/Organic Carbon (H/C_{org})

At $H/C_{org} < 0.7$ all biochars have MRT of > 100 years

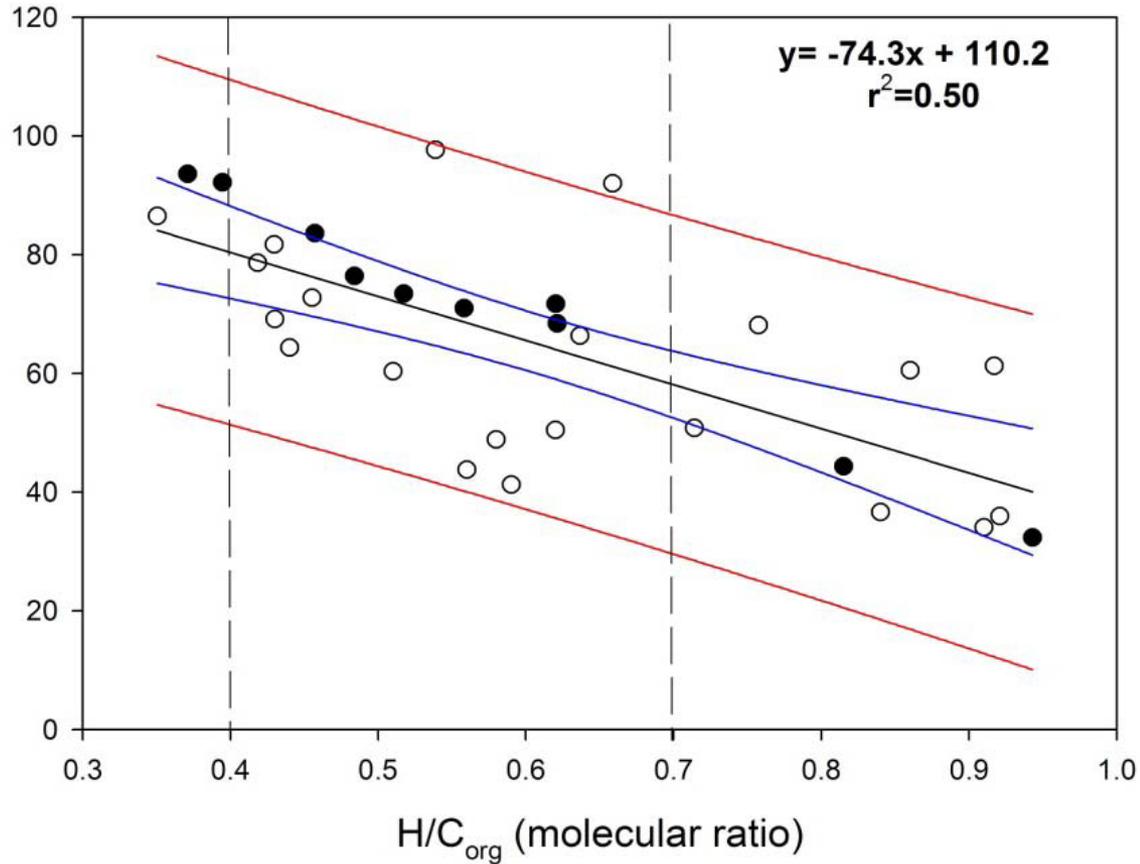


J. Lehmann, S. Abiven, M. Kleber, G. Pan, B.P. Singh, S. Sohi, A. Zimmerman. Persistence of biochar in soil. In: Biochar for Environmental Management - Science and Technology, 2nd edition. Johannes Lehmann and Stephen Joseph (eds.). Earthscan, and references therein



Biochar Stability

Amount (%) of C remaining
in Biochar after 100 years





Biochar Stability

H/C_{org} and BC_{+100} equivalences at 95% confidence

Chosen values represent **conservative estimates** of biochar C expected to remain based on experimental data

Two levels identified:

1. $H/C_{org} < 0.4 \rightarrow$ at least 70% biochar C expected to remain after 100 years
2. $H/C_{org} < 0.7 \rightarrow$ at least 50% biochar C expected to remain after 100 years

H/C_{org}	BC_{+100} (%)			
	Mean	Lower Limit	Upper Limit	Chosen Value
0.4	80.5	72.6	88.2	70
0.5	73.1	67.1	78.9	50
0.6	65.6	60.5	70.6	50
0.7	58.2	52.5	63.8	50



Biochar Potential

- Biochar production rate – 0.10 lb biochar/lb biomass
- Carbon content of biochar – 0.75 lb C/lb biochar
- CO₂ sequestered in biochar – **0.28 MT CO₂/BDT biomass**



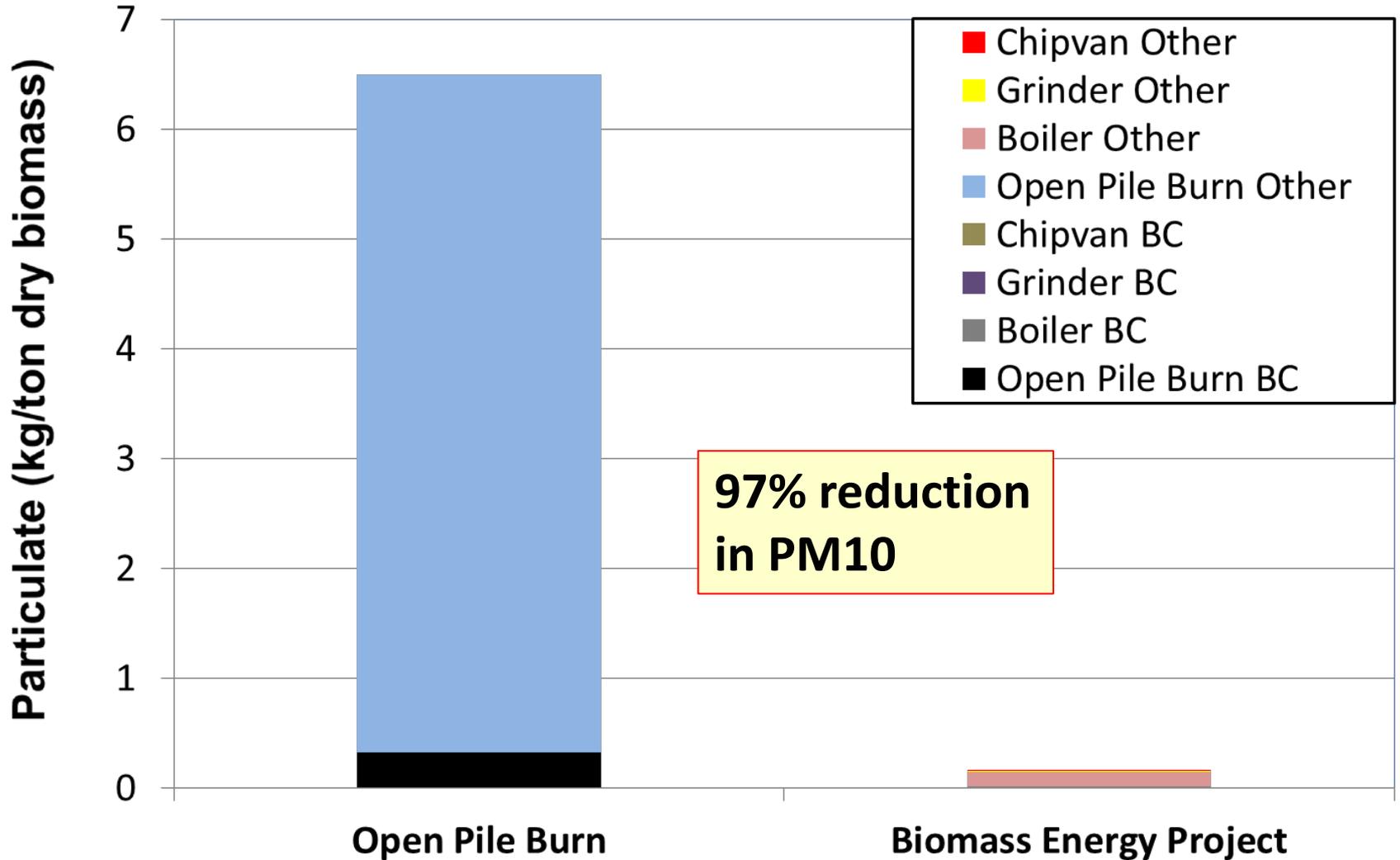
Black Carbon

- Product of incomplete combustion
 - Soot
- Small particles
 - Travel long distance through air
- “Short-lived climate forcing”
 - 900 times by weight more potent than CO₂



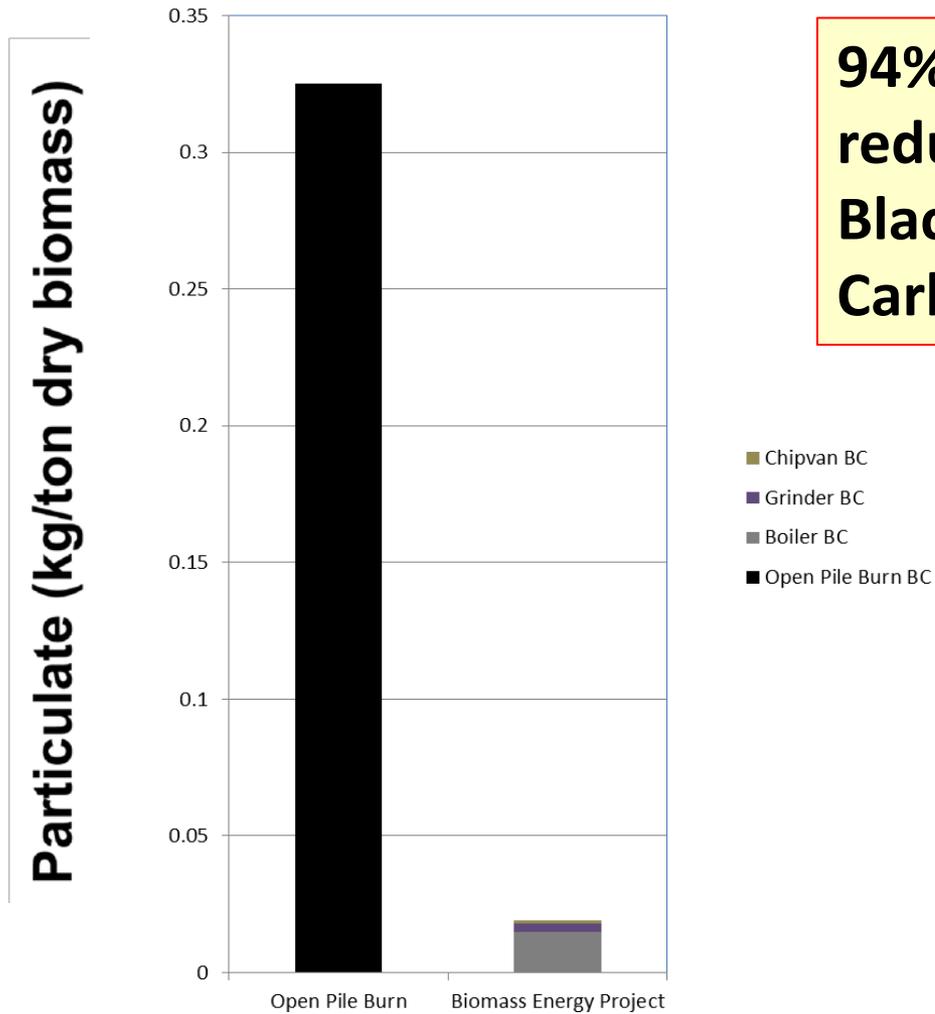


Black Carbon





Black Carbon



**94%
reduction in
Black
Carbon**



Black Carbon

- Working to develop a GHG offset protocol for black carbon reductions achieved through avoided open pile burning
 - Forest slash
 - Agricultural residues (orchard thinnings, removals, food processing wastes)
- Forming a research team to characterize BC emissions from open pile burning
 - Multi-agencies including UC, CAPCOA, CAL FIRE, USFS
- Concurrent effort to evaluate black carbon reductions from wood stove upgrades and replacements



Forest Fuel Treatment Impact on Wildfires and Emissions

- Working to continue research and development of GHG offset protocol for avoided wildfire from forest fuel treatment thinning projects
 - Assembling multi-stakeholder research team – USFS, CAL FIRE, Spatial Informatics Group, UC Berkeley, CEC, California Forest Association, private forest land owners
 - Securing funding
- Case study demonstration
 - Sierra Nevada forested land in watershed at risk for catastrophic wildfire, public and private ownership, on-the-ground inventory
 - Fuel treatment prescription designs considering various management alternatives
 - Evaluate wood products lifecycle specific to local mill and wood products displacement of alternative building materials (concrete, steel)
 - Develop protocol that can be practically implemented but flexible to consider site specific considerations including fire return interval and wildfire emissions on a fire-shed basis