Biochar
Greenhouse Gas Offset Protocol

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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

PCAPCD / CAPCOA GHG Exchange

American Carbon Registry

All/any Biomass

Carbon sequestration
GHG offset protocol

Agricultural Field Trials

Water retention
Fertilizer displacement
Plant growth

2012 – Nov 2014

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

Dec 2014

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/Corg < 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

The diagram illustrates the stability of biochar over time. The carbon remaining is shown as a percentage of the initial biomass. The graph indicates the percentage of labile carbon at different stages:

- 10% labile C
- 50% labile C
- 90% labile C

The pyrolysis stage shows a significant loss (~50% loss) of carbon immediately after the biomass is subjected to pyrolysis. Further, the graph shows the long-term stability of biochar in the soil over time, with the carbon content decreasing gradually.
Biochar Stability

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

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

Biochar Stability

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

\[ y = -74.3x + 110.2 \]
\[ r^2 = 0.50 \]
Biochar Stability

H/C\textsubscript{org} and BC\textsubscript{+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\textsubscript{org} < 0.4 $\Rightarrow$ at least 70% biochar C expected to remain after 100 years
2. H/C\textsubscript{org} < 0.7 $\Rightarrow$ at least 50% biochar C expected to remain after 100 years

<table>
<thead>
<tr>
<th>H/C\textsubscript{org}</th>
<th>Mean</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
<th>Chosen Value</th>
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<td>58.2</td>
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<td>63.8</td>
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</table>
Biochar Potential

- **Biochar production rate** – 0.10 lb biochar/lb biomass
- **Carbon content of biochar** – 0.75 lb C/lb biochar
- **$\text{CO}_2$ sequestered in biochar** – 0.28 MT $\text{CO}_2$/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 CO$_2$
Black Carbon

97% reduction in PM10

Particulate (kg/ton dry biomass)

Open Pile Burn

Biomass Energy Project

Legend:
- Chipvan Other
- Grinder Other
- Boiler Other
- Open Pile Burn Other
- Chipvan BC
- Grinder BC
- Boiler BC
- Open Pile Burn BC
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