California has a forest biomass problem

Any solution of this problem should consider full impact

California Biopower impacts Project addresses several considerations, including:

- Total recoverable residue resource
- Life Cycle emissions impacts
- Wildfire effects of residue removal
- Changes to soil emissions

Significant spatial and supply-chain variability in the impacts of biomass energy

Lack of transparency in Life-Cycle accounting

The CBI Project aims to support policy makers and the private sector in shaping this industry
LCA Conceptual Structure

Mobilize for bioenergy

Remain in the field

Collection

Transportation

Processing

Use

Use case emissions

Reference scenario

Pile burn

Decay

Wildfire

Reference emissions
LCA Conceptual Structure

Mobilize for bioenergy

Use case emissions

Product Life Cycle

Reference scenario

Remain in the field

Pile burn

Decay

Wildfire

Reference emissions

January 29th, 2019
LCA Conceptual Structure

Mobilize for bioenergy

Use case emissions

Remain in the field

Reference emissions

Reference scenario

Product Life Cycle

Pile burn

Decay

Wildfire

January 29th, 2019
Reference emissions

- Exponential decay – rate varying based on:
  - Composition: Material type and species
  - Disposition: Piled vs scattered material
  - Climate: Temperature and residue moisture level

- Wildfire emissions
  - Modeled using Consume model (USFS)
  - Applied to residue based on CALFIRE projections of fire probability

- Modeled out 100 years
Take-home messages

- Net emissions are variable and sensitive to a handful of characteristics.
- Identify what they are, and study them deeply.
- Target policy to mobilize the residues that offer most benefits.
- May be net reduction in criteria pollutant emissions, but exposure is what matters.
- Better tracking of pile burn emissions.
Thank you!
Kevin Fingerman, Ph.D.
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- LCA Methods and Forest Operations
- CORRIM
- Wildfire Modeling
- Humboldt State: Dr. Jeffrey Kane
- Forest Resource Assessment and Transport Modeling
- Univ. of Washington: Luke Rogers
- Soil Nutrient and Carbon Balance
- CSU Chico: Dr. Garrett Liles
- CA Biomass Policy
- Watershed Resource and Training Center
- Forest Product Utilization Economics
- The Sierra Institute for Community and Environment

Technical Advisory Committee
Dr. Andrea Tuttle, Chair

California Energy Commission
Schatz Energy Research Center
Humboldt State University
Sponsored Programs Foundation
Foundation
Residue Base of California Forests with 40% Basal Area Thin From Above
Residue Base of California Forests with 40% Basal Area Thin From Below

Total Residue (lbs per acre)
- 0 - 3,300
- 3,400 - 7,800
- 7,900 - 14,000
- 15,000 - 22,000
- 23,000 - 105,000
Model Capabilities/Sensitivities

- Location of source and destination in transport network
- “Counterfactual” fate of biomass
  - Burn probability, decomposition rate, etc.
- Wildfire frequency projection
- Supply chain characteristics such as harvest equipment, fuel use, landscape specifics, post-harvest treatment, and conversion technologies
- End-use technology pathway
- Analytical time horizon
Mass Allocation of In-Field Biomass Residues

- Scattered
- Remaining Piles
- Burned Piles

*Soil efflux not shown

Emissions from in-field biomass residues

- Highest annual emissions are from pile burn (year 0)

- Wildfire
- Decay
- Pile Burn

Cumulative CO$_2$ Emissions, mT

Years Since Treatment

Annual CO$_2$ Emissions, mT yr$^{-1}$
Key issues of scope

- We assume that the feedstocks are “true wastes” – they would not have otherwise been used.
- As such, we don’t allocate upstream emissions or sequestration to bioenergy supply chains.
- Forestry and agricultural activity happens in both bioelectricity and reference cases, so land use emissions are not considered.
- We don’t consider the growth phase – only the reference fate for same material.
Andrea Tuttle – chair – Pacific Forest Trust; US Endowment for Forestry

Annette Cowie – Government of New South Wales

Alan Di Vittorio – Lawrence Berkeley National Laboratory

Jacopo Giuntoli – International Council on Clean Transportation

Amy Clark Eagle / Corey Brinkema – Forest Stewardship Council

Neil Ewald – Green Diamond Resource Company

Han-Sup Han – Northern Arizona University Ecological Restoration Inst.

Garvin Heath – National Renewable Energy Laboratory

Matt Hurteau – University of New Mexico Dept. of Biology

Brian Kittler – Pinchot Institute for Conservation

Matt Kruemenauer – Consortium for Advanced Wood-to-Energy Systems

Angie Lottes – California Department of Forestry and Fire Management

Tadashi Moody – California Department of Forestry and Fire Management
<table>
<thead>
<tr>
<th>CutTPA</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CutBA</td>
<td>Harvested basal area (sq ft per acre).</td>
</tr>
<tr>
<td>CutQMD</td>
<td>Harvested quadratic mean diameter (inches).</td>
</tr>
<tr>
<td>CutCV6LT9</td>
<td>Harvested cubic foot volume per acre to a 6 inch top in trees with DBH less than 9 inches.</td>
</tr>
<tr>
<td>CutCV6GE9</td>
<td>Harvested cubic foot volume per acre to a 6 inch top in trees with DBH greater than or equal to 9 inches.</td>
</tr>
<tr>
<td>CutCV4To6</td>
<td>Harvested cubic foot volume per acre between 4 to 6 inches stem diameter.</td>
</tr>
<tr>
<td>CutBF6LT9</td>
<td>Harvested board foot volume to a 6 inch top in trees with DBH less than 9 inches.</td>
</tr>
<tr>
<td>CutBF6GE9</td>
<td>Harvested board foot volume to a 6 inch top in trees with DBH greater than or equal to 9 inches.</td>
</tr>
<tr>
<td>CutStem6BLT9</td>
<td>Harvested stem biomass (pounds per acre) to a 6 inch top in trees with a DBH less than 9 inches.</td>
</tr>
<tr>
<td>CutStem6BGE9</td>
<td>Harvested stem biomass (pounds per acre) to a 6 inch top in trees with a DBH greater than or equal to 9 inches.</td>
</tr>
<tr>
<td>CutStem4To6B</td>
<td>Harvested stem biomass (pounds per acre) between 4 to 6 inches stem diameter.</td>
</tr>
<tr>
<td>CutBarkStem6BLT9</td>
<td>Harvested bark biomass (pounds per acre) to a 6 inch top in trees with a DBH less than 9 inches.</td>
</tr>
<tr>
<td>CutBarkStem6BGE9</td>
<td>Harvested bark biomass (pounds per acre) to a 6 inch top in trees with a DBH greater than or equal to 9 inches.</td>
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<tr>
<td>CutBarkStem4To6B</td>
<td>Harvested bark biomass (pounds per acre) between 4 to 6 inches stem diameter.</td>
</tr>
<tr>
<td>CutBranchB</td>
<td>Harvested branch biomass (pounds per acre).</td>
</tr>
<tr>
<td>CutFoliageB</td>
<td>Harvested foliage biomass (pounds per acre).</td>
</tr>
<tr>
<td>CutStumpB</td>
<td>Harvested stump biomass (pounds per acre).</td>
</tr>
<tr>
<td>CutBarkStumpB</td>
<td>Harvested stump bark biomass (pounds per acre).</td>
</tr>
</tbody>
</table>
Transportation network

Distance from Biomass Energy Facilities by Road Network

Distance from Biomass Energy Facilities by Road Network

MW Nameplate of Operational Biomass Facilities
- 35.6 - 58.0
- 26.6 - 35.5
- 15.1 - 26.5
- 1.1 - 15.0
- 0.0 - 1.0

Distance in Miles

5 120 240

Distance in Miles

5 120 240
Task 3: Fire Risk Assessment

- CO₂ Emissions, lbs/Acre
  - 1 hour
  - 10 hour
  - 100 hour
  - 1,000 hour
  - 10,000 hour
  - >10,000 hour

- Additional Fuel, % Added

- Fuelbed:
  - 15
  - 16
  - 17

- Combustion Phase:
  - flaming
  - residual
  - smoldering
Task 4: LCA Framework

Mass Distribution of Residues Left in Field by Size Class

- Wildfire
- d>12
- 6<d<12
- 3<d<6
- 1<d<3
- 0.25<d<1
- d<0.25
- litter
- duff

Decayed Mass

Remaining Mass

Yrs. since Treatment

Mass Fraction of Remaining Residues
Spatial data in LCA

User Input:
- Harvest area
- Power plant location
- Biomass type

Online Interface:
- Spatially distributed biomass resource data
- Forest type, road networks, any other spatially-discrete data

Spatial Information:
- Slope, biomass resource and species, collection equipment, soil type, climate
- Fire Information:
  - Baseline fire return interval, changes to fire dynamics
- Transportation Information:
  - Travel time on forest road, travel time on highway

Spreadsheet Model:
- Includes baseline emission factors (CO2/unit & Intensity factors (unit/ton biomass))
- Not tracking upstream life cycle emissions of all inputs - just those emissions endogenous to bioenergy systems (e.g., diesel has a static emission factor)
- Users can modify intensity factors based on their specific project and context.

Outputs:
- Emissions, Climate Metrics
Example pathway

- User defines material type and harvest type
  - Woody biomass from harvest residue in forest type X
- This triggers ‘utilization factors’ for equipment \((\text{Han})\)
  - \# operation minutes of equipment type a, b, and c per BDT of material at the landing
- Each of these ‘utilization factors’ has associated emission factors. \((\text{CORRIM})\)
  - \(x\) kg CO\(_2\)e per minute of operation of equipment type a, etc.
  - These are themselves life cycle characteristics, but we don’t build them into the customizable model (except maybe device fuel efficiency and/or fuel CI)
- Transport distance and equipment ‘utilization factors’ \((\text{UW})\)
- These characteristics are defaults that can be user-customized as necessary.