

Modular/Mobile Wood Processing Technologies

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- The target audience of this document are communities, Resource Conservation Districts, Fire Safe Councils, land managers, etc. that are looking for options to utilize their forest management residue, short of building a stationary bioenergy plant that takes years to finance and build.





- Disclaimer: The list are examples of currently available technologies for processing forest biomass on a modular/mobile scale. They are representative of technologies and are not to be considered as endorsement of particular manufacturers or being vetted.



Categories

- Waste Reduction
- Biomass Baling
- Biochar
- Power/Heat Generation
- Syngas/Biochar/Bio-Oil Production
- Solid Fuel
- Erosion Control

Format

Name
<i>Description</i>
Landing size
Equipment footprint
Utilities required on site
Air permit required?
Emissions
Ground disturbance
Transportation (Equipment)
Transportation (Product)
In use in California?
Pricing (Equipment)
Pricing (Product)
Operating Costs
Material/Feedstock quality
Material/Feedstock sizing
Sorting required?
Preferred moisture content
Consumption rate
Production rate

Waste Reduction

- FireBox
- BurnBoss





FireBox

Pollution control device for open burning of clean wood waste (air curtain burner, incinerator).

Landing size	Less than 1/8 acre for machine, 1 to 4 acres for feedstock pile.
Equipment footprint	Smallest 7' x 24'; largest 12' x 41'
Utilities req'd on site	No utilities for diesel powered. For electrical drive 480V, 3PH
Air permit req'd?	Yes - Title V Operating Permit (40 CFR part 70)
Emissions	Lowest Particulate Matter possible (<1 lb/ton).
Ground disturbance	No heat impact with optional floor or 4" depth w/o floor.
Transportation (Equipment)	Transport off-site with any flat deck trailer or lowboy type trailer. Reposition on-site by dragging "skid" based.
Transportation (Product)	Carbon ash and Biochar is returned to the soil around the machine or collected and sold.
In use in California?	Yes, by CalParks, CAL FIRE, municipalities, growers, and National Parks.
Pricing (Equipment)	\$99,000 - \$168,000
Pricing (Product)	Biochar is sold from approximately \$100 to \$140 per cubic yard.
Operating Costs	\$6.00/hour to \$7.50/hour + labor
Material/Feedstock quality	Clean wood waste, stumps, trees, (incl partially burned), slash, tumbleweeds, C&D wood waste.
Material/Feedstock sizing	Up to 29' in length, no chips or sawdust.
Sorting required?	No sorting, grinding, chipping or any preprocessing required
Preferred moisture content	Not an issue
Consumption rate	4 to 13 tons/hour
Production rate	Biochar (if collected) approximately 10 -15 cubic yards/day





BurnBoss

Pollution control device for open burning of clean wood waste (air curtain burner, incinerator).

Landing size	Machine and one day's feedstock pile, approximately 1/4 acre.
Equipment footprint	8' x 20'
Utilities req'd on site	None, diesel powered.
Air permit req'd?	Yes - Title V Operating Permit (40 CFR part 70)
Emissions	Lowest Particulate Matter possible (<1 lb/ton).
Ground disturbance	Heat impact less than 4" deep and 4' x 12'
Transportation (Equipment)	DOT approved trailer, towing with HD pick-up truck
Transportation (Product)	Ash and biochar is returned to the soil around the machine or collected and sold.
In use in California?	Yes, BurnBoss® was originally designed for CAL FIRE. Currently used by CalParks, CAL FIRE, municipalities, growers, and National Parks.
Pricing (Equipment)	Approx. \$53,000
Pricing (Product)	Biochar is sold from approximately \$100 to \$140 per cubic yard.
Operating Costs	\$1.30 per hour + labor
Material/Feedstock quality	Clean wood waste, stumps, trees, (incl partially burned), slash, tumbleweeds, and C&D wood waste
Material/Feedstock sizing	Needs to fit in the 4' by 12' opening. No chips or sawdust.
Sorting required?	No sorting, grinding, chipping or any preprocessing required.
Preferred moisture content	Not an issue
Consumption rate	10 to 20 cubic yards/hour
Production rate	If biochar is collected, approximately 1 - 2 cubic yards/day.



Baling

- Biomass Baler





Biomass Baler

Slash compactor for more efficient transport, storage, and handling.

Landing size	N/A
Equipment footprint	8' x 22'
Utilities req'd on site	N/A
Air permit req'd?	Yes - Title V Operating Permit (40 CFR part 70)
Emissions	Model 2054 will be CARB compliant
Ground disturbance	N/A - Street legal trailer
Transportation (Equipment)	Towable with 1-ton truck
Transportation (Product)	Flatbed truck, trailer
In use in California?	Yes (for demos)
Pricing (Equipment)	\$100,000 - \$175,000 depending on options
Pricing (Product)	N/A
Operating Costs	Depends on configuration and use
Material/Feedstock quality	Brush, slash, vegetation management trimmings
Material/Feedstock sizing	length <= 4', diameter <= 12"
Sorting required?	No
Preferred moisture content	Any
Consumption rate	N/A
Production rate	1 bale/hour, size: 32" x 48" x 64", ~1,300 lbs each

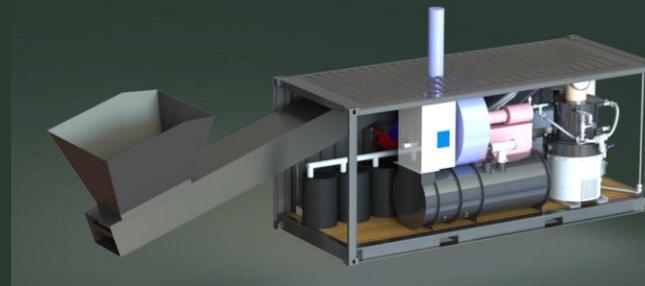


Biochar

- Carbonator



- Chartainer



Biochar ct'd

- Retort
- Flame Cap Kiln

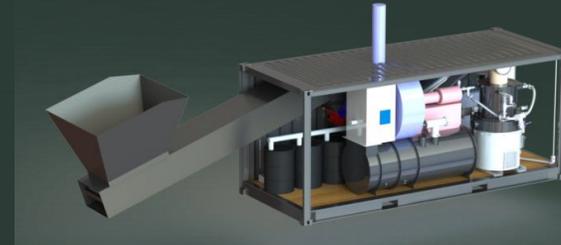




Carbonator

Advanced wood debris conversion system to biochar (air curtain burner)

Landing size	350' radius
Equipment footprint	40' x 11'-10"
Utilities req'd on site	Water supply (this can be provided by way of water truck)
Air permit req'd?	Yes - Title V Operating Permit (40 CFR part 70)
Emissions	Engine: EO# U-R-022-0218;
Ground disturbance	57 psi
Transportation (Equipment)	Lowboy trailer
Transportation (Product)	Steel container
In use in California?	Yes
Pricing (Equipment)	~\$700,000
Pricing (Product)	\$
Operating Costs	~\$20/ton
Material/Feedstock quality	clean logs, partially burned trees, limbs, brush, stumps and other wood based debris
Material/Feedstock sizing	max. 25' length
Sorting required?	Not required
Preferred moisture content	N/A
Consumption rate	15-20 tons/hour
Production rate	1,800 - 2,200 lbs biochar/hour



Chartainer

Containerized combined Heat and Biochar (CHAB) pyrolyzer system (in development)

Landing size	300 sqft
Equipment footprint	8' x 40'
Utilities req'd on site	No electricity required--works in a totally off-grid context
Air permit req'd?	No
Emissions	Third-party testing has been done, the results are being finalized. Wood gases are flared.
Ground disturbance	
Transportation (Equipment)	20' shipping container
Transportation (Product)	
In use in California?	First deployment is Yosemite National Park, 2020
Pricing (Equipment)	Beta units are \$300k, final version will be \$150/200k.
Pricing (Product)	Biochar can be sold in a Local Carbon Network scheme for ongoing revenue. See https://localcarbon.net/
Operating Costs	
Material/Feedstock quality	wood chips, nut shells, and other woody biomass (e.g. stone fruit pits).
Material/Feedstock sizing	1/8 inch - 2 1/2 inch
Sorting required?	Generally no. This is a fairly fuel-flexible machine if you have any standard chipper.
Preferred moisture content	<30%, generally none. This is a fairly fuel-flexible machine if a standard chipper is available.
Consumption rate	250 kg/hour
Production rate	500 kW thermal, 18%+ biochar yield by mass



Retort

Wood debris conversion system to biochar.

Landing size	
Equipment footprint	~9' x 5.5' (with trailer: ~12.5' x 7.2')
Utilities req'd on site	None
Air permit req'd?	No
Emissions	During start-up similar to a small bonfire, then clean except for flame from the temperature control valve.
Ground disturbance	None
Transportation (Equipment)	Towed
Transportation (Product)	Bulk bagged or smaller bags
In use in California?	No
Pricing (Equipment)	~\$18,000 - \$22,300 (£14,350 GBP; £17,650 GBP with trailer).
Pricing (Product)	\$ variable
Operating Costs	Labor cost/burn, some simple fettling required during lifetime.
Material/Feedstock quality	any solid woody biomass and animal bones
Material/Feedstock sizing	length <= 7', diameter <= 6", but diameter can exceed 6" if wood cut to shorter lengths. Split wood ideal.
Sorting required?	No
Preferred moisture content	<20%, but will process green wood
Consumption rate	~60 cu ft/day
Production rate	~30 cu ft/day biochar (assuming 50% conversion efficiency by volume)



Flame Cap Kiln

Low-tech wood debris conversion to biochar.

Landing size	
Equipment footprint	92" x 70"
Utilities req'd on site	Water supply for quenching
Air permit req'd?	No
Emissions	Similar to a well-tended small bonfire
Ground disturbance	Heat
Transportation (Equipment)	Pick-up truck, utility trailer, 4 people
Transportation (Product)	Bulk bagged or smaller bags
In use in California?	Yes
Pricing (Equipment)	~\$1,200
Pricing (Product)	\$ variable
Operating Costs	Variable
Material/Feedstock quality	Slash, tree and vineyard prunings, reed
Material/Feedstock sizing	length \leq 4', diameter \leq 4"
Sorting required?	Yes
Preferred moisture content	$<$ 20%
Consumption rate	11 cu yd/day
Production rate	2 cu yd/day (conversion efficiency ~15-22% by volume)

Power/Heat Generation

- PGFireBox



- Power Pallet



- Power Pallet Hybrid Container





PGFireBox

Advanced wood debris conversion system to power/heat (air curtain burner, co-gen, CHP)

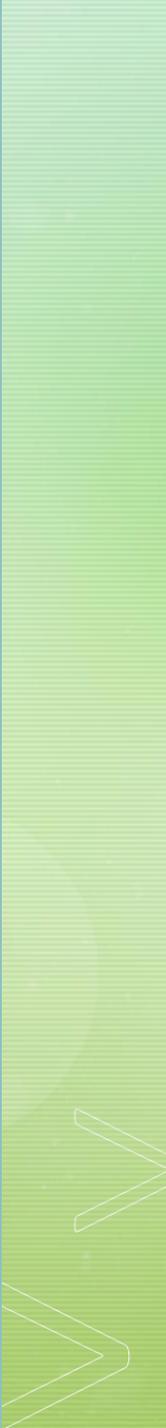
Landing size	Less than ¼ acre for machine. 1 to 4 acres for brush pile.
Equipment footprint	Approx. 40' x 40' and Cooling 20' x 8'.
Utilities req'd on site	Grid connection, 480V 3PH
Air permit req'd?	Yes - Title V Operating Permit (40 CFR part 70)
Emissions	Lowest Particulate Matter possible (<1 lb/ton).
Ground disturbance	Heat impact 4" depth.
Transportation (Equipment)	Easily moved on three flatbed trucks. All three machines are road legal dimensions, no special road permits required. All accessories pack into the three units for transportation.
Transportation (Product)	Ash and biochar is returned to the soil around the machine or collected and sold.
In use in California?	Yes, currently purchased by municipalities. The PGFireBox qualifies for landfill diversion credits. Agricultural and Forestry markets.
Pricing (Equipment)	Approx. \$830,000 to \$4,200,000
Pricing (Product)	\$
Operating Costs	Labor. The machine generates power for itself and energy (thermal or electric) to sell plus the sale of waste elimination.
Material/Feedstock quality	Clean wood waste, stumps, trees, (incl. partially burned), slash, tumbleweeds, and C&D wood waste.
Material/Feedstock sizing	Up to 29' in length, no chips or sawdust.
Sorting required?	No sorting, grinding, chipping or any preprocessing required
Preferred moisture content	Not an issue
Consumption rate	7 to 13 tons/hour
Production rate	100kW, 500kW, 1,000kW; Biochar (if collected) approximately 10 - 15 cubic yards/day



Power Pallet

Advanced wood debris conversion system to power/heat (co-gen, CHP)

Landing size	50 sqft
Equipment footprint	75" x 56"
Utilities req'd on site	Electrical hookup: utility grid, microgrid, or directly powering machinery/storage, etc.
Air permit req'd?	No
Emissions	Emissions profile available upon request, validated from third-party testing and permitted in California.
Ground disturbance	
Transportation (Equipment)	Pallet/Crate
Transportation (Product)	Wire, pipe
In use in California?	Yes
Pricing (Equipment)	\$65,000
Pricing (Product)	Biochar, electricity, and heat can be negotiated as part of ongoing revenue in a Local Carbon Network scheme. See https://localcarbon.net/
Operating Costs	
Material/Feedstock quality	Woody biomass (wood chips, nut shells, stone fruit pits) with processing (chipping and some sorting)
Material/Feedstock sizing	1/2 inch – 1 1/2 inch (1 cm – 4 cm)
Sorting required?	Yes
Preferred moisture content	5% – 30%
Consumption rate	1.0 kg/kWh
Production rate	25 kW electric, 50 kW thermal, 5% yield biochar; 50 kW electric, 100 kW thermal, 5% yield biochar





Power Pallet Hybrid Container

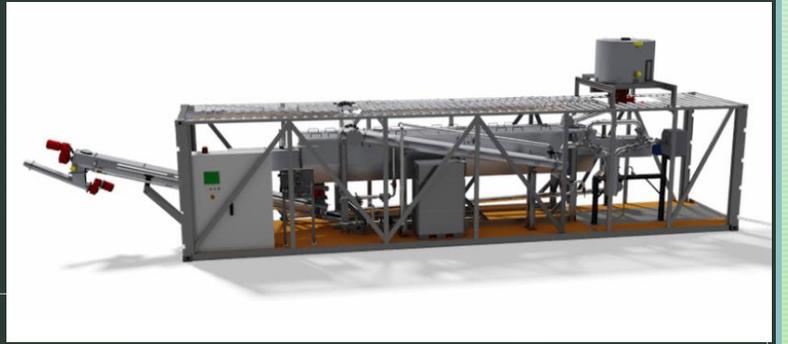
Modular power plant converting clean wood waste into on-site, on-demand electricity for both on, off-grid, and microgrid use.

Landing size	650 sqft
Equipment footprint	23' x 16'
Utilities req'd on site	Electrical hookup: utility grid, microgrid, directly powering machinery/storage, etc.
Air permit req'd?	
Emissions	Emissions profile available upon request, validated from third-party testing and permitted in California.
Ground disturbance	
Transportation (Equipment)	20' shipping container
Transportation (Product)	Wire
In use in California?	No
Pricing (Equipment)	Finalized product will be ~\$300k
Pricing (Product)	Electricity and heat can be negotiated as part of ongoing revenue in a Local Carbon Network scheme. See https://localcarbon.net/
Operating Costs	
Material/Feedstock quality	Woody biomass (wood chips, nut shells, stone fruit pits) with processing (chipping and some sorting)
Material/Feedstock sizing	1/2 inch - 1 1/2 inch (12-40 mm)
Sorting required?	Yes
Preferred moisture content	<80%
Consumption rate	250 kg/hour
Production rate	250 kW electric, 500 kW thermal.

Syngas/Biochar/Bio-Oil Production

- Containerized Pyrolysis Module
- Modular Gasification Unit





Containerized Pyrolysis Module

Thermochemical conversion through torrefaction, pyrolysis, or gasification processes to convert useful energies or resources from waste products.

Landing size	
Equipment footprint	40' x 8'
Utilities req'd on site	400V 3PH, 100 kW; water for char cooling: 4m ³ /hour
Air permit req'd?	No
Emissions	None
Ground disturbance	
Transportation (Equipment)	40ft shipping container
Transportation (Product)	Wire, barrel, bulk bagged
In use in California?	No
Pricing (Equipment)	>\$1MM
Pricing (Product)	\$ variable
Operating Costs	
Material/Feedstock quality	Wood chips, sawdust, nut shells, dry sludges, plastics, RDF/SRF (Refuse derived fuel/Solid recovered fuel), calorific fractions of municipal and industrial waste;
Material/Feedstock sizing	<=20mm
Sorting required?	
Preferred moisture content	10% - 20%
Consumption rate	Up to 16 tons/day
Production rate	Up to 4.8 tons/day biochar; up to 8 tons/day bio-oil; up to 10 MJ/m ³ , up to 450 kW (9 MWh/day) syngas



Modular Gasification Unit

Thermochemical conversion through gasification process to electricity and biochar.

Landing size	1,000 sq ft
Equipment footprint	9' x 29', 4' x 11'
Utilities req'd on site	Water for cooling, power grid access if net metering
Air permit req'd?	
Emissions	Meets San Joaquin Valley Air Pollution Reqs
Ground disturbance	Concrete slab or rock bed
Transportation (Equipment)	2 trailers; 1 gasifier + 1 genset
Transportation (Product)	Super sacks or drums
In use in California?	Yes
Pricing (Equipment)	\$450,000
Pricing (Product)	variable
Operating Costs	3 people per 5 units
Material/Feedstock quality	Wood pellets, small wood chips, nut shells, other as reviewed
Material/Feedstock sizing	$\leq 3/4$ inch
Sorting required?	must remove small fines
Preferred moisture content	$< 20\%$ or heat required to dry on input
Consumption rate	250 lbs/hour
Production rate	up to 35 lbs/hour, depending on feed rate

Solid Fuel

- Pelleting Line



- Briquetter





Pelleting Line

Sawdust to heating pellets

Landing size	
Equipment footprint	~6' x 30'
Utilities req'd on site	Electricity (400V 3PH)
Air permit req'd?	No
Emissions	None
Ground disturbance	None
Transportation (Equipment)	Pallet/Crate
Transportation (Product)	supersacs, bins
In use in California?	No
Pricing (Equipment)	~\$110,000
Pricing (Product)	\$
Operating Costs	
Material/Feedstock quality	clean sawdust and shavings
Material/Feedstock sizing	<=6mm
Sorting required?	
Preferred moisture content	
Consumption rate	~ 400 lbs/hour
Production rate	~ 400 lbs/hour



Briquetter

Briquetting of wood shavings, sawdust, wood chips.

Landing size	
Equipment footprint	Various; smallest 52" x 59", largest 118" x 130"
Utilities req'd on site	Electricity (400V 3PH)
Air permit req'd?	No
Emissions	None
Ground disturbance	None
Transportation (Equipment)	
Transportation (Product)	
In use in California?	Yes
Pricing (Equipment)	\$35,000 to \$300,000
Pricing (Product)	
Operating Costs	Varies by machine and materials
Material/Feedstock quality	wood chips, saw dust
Material/Feedstock sizing	shavings, sawdust, chips
Sorting required?	No
Preferred moisture content	<15%
Consumption rate	various; smallest 120 lbs/hour, largest 3,300 lbs/hour
Production rate	various; smallest 120 lbs/hour, largest 3,300 lbs/hour

Erosion Control

- WoodStraw



- Wood Shred



Modular/Mobile Wood Processing Technologies

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