



# WEST BIOFUELS

**Innovative Systems for Bio-energy  
Production in Agriculture and Forest Sectors**

**September 2018**

# Company Profile

What?

- Integrated bio-energy and bio-products technology supplier for Ag and Forest industry

Why?

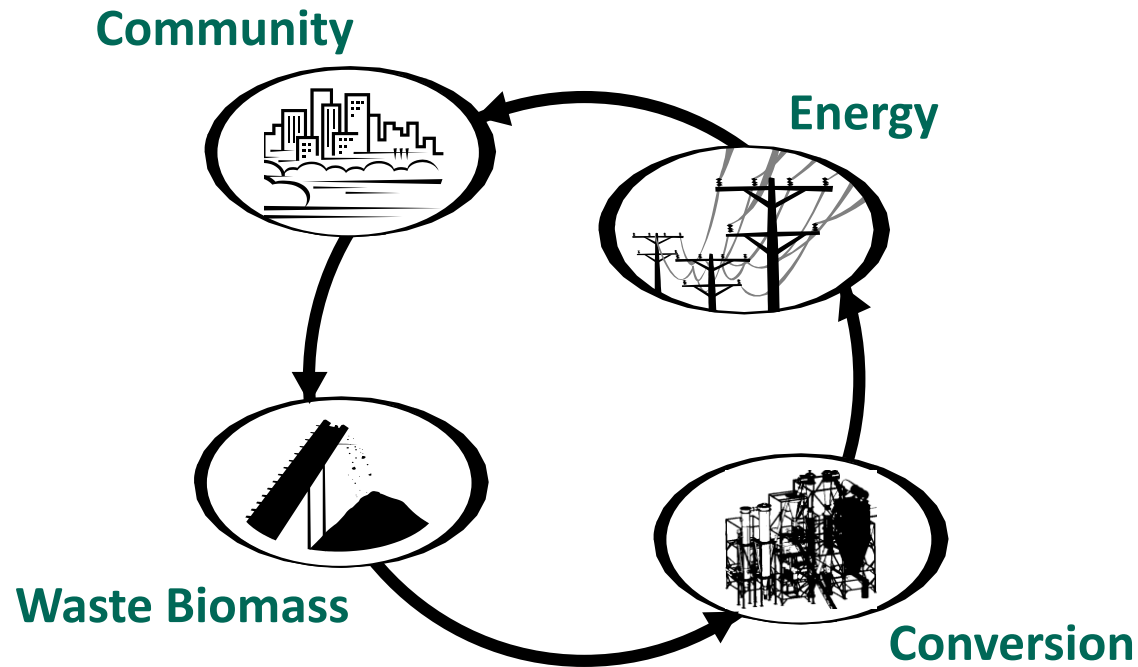
- Continuously generated biomass from agriculture production and forest management
- On-site utilization of surplus biomass creates revenue, jobs, and reduced carbon footprint

Where?

- Engineering and testing facility in Woodland, CA

# West Biofuels Mission

*To reinvent bioenergy production in ways that help us become energy independent, lower our carbon footprint, create local green jobs and foster economic growth.*



# Broad Feedstock Options

Wood residue



Shells



Hulls



Prunings



Removals

Stalks

Dry Manure

## Feedstock

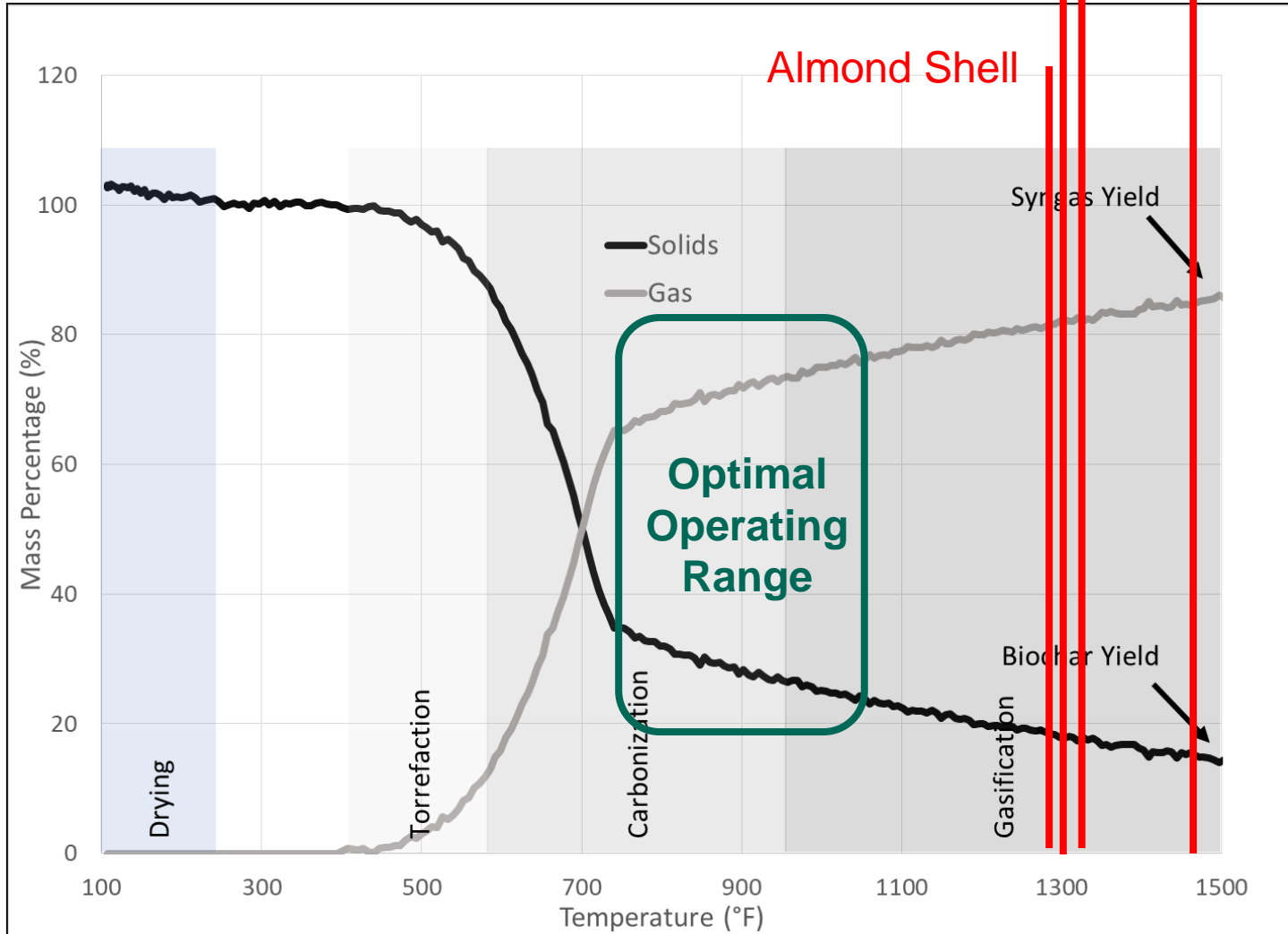
- Gasification should be engineered to accommodate broad feedstock range

- Operating parameters can be tailored

- High level of technology flexibility

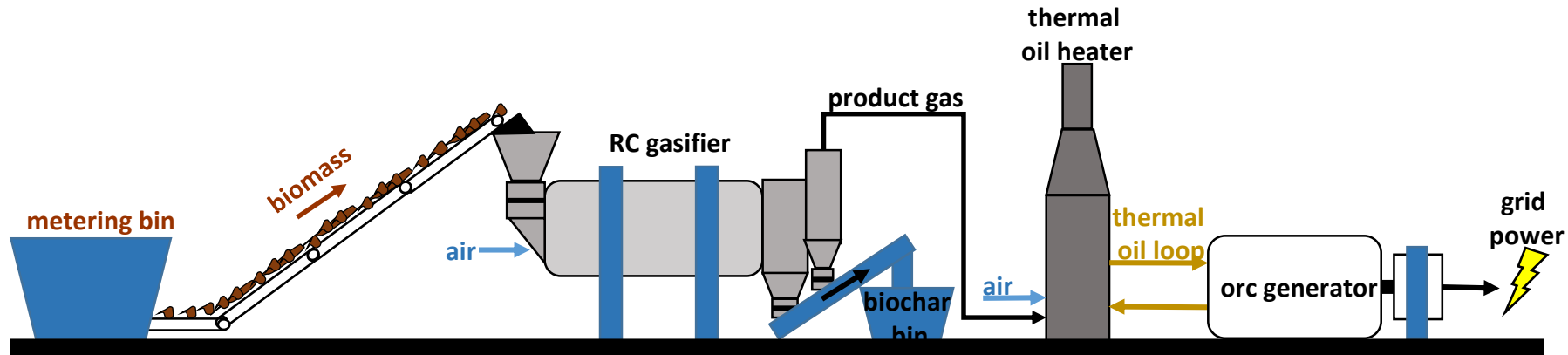
Feedstock Type	Average Ash Content
Clean Wood Chips	0.7%
Walnut Shells	1.0%
Ag Prunings	2.2%
Almond Shells	3.6%
Almond Hulls	7.7%
Rice Hulls	20%
Manure	28-40%

# Conversion Temperature



Red lines indicate when slag will form based on the hottest (not average) temperature within the system

# PROCESS LAYOUT: Rotary Gasifier



- Integrates proven technology to generate renewable power
  - Gasifier produces uniform gas and biochar in a rotary drum reactor designed to thermally process biomass without blockages or hot spots
  - Thermal oil heater cleanly consumes product gas to heat thermal oil
  - Organic Rankine cycle (ORC) generator produces electricity by utilizing the heat transferred from the thermal oil without additional emissions

# Opportunity

- Current markets
  - No long term off-take agreements (<\$0 to \$30/BDT)
  - Closing and ageing conventional biomass plants
  - Prohibition and restrictions on open burning and other costly and unfavorable disposal options
- New markets – Bioenergy + Biochar
  - Electricity: Agriculture is BioMAT Cat 2: \$187/MWh, Forestry is BioMAT Cat 3: \$199/MWh
  - Biochar: \$250 - \$2,000+/BDT of biochar



# Biochar

## Why our biochar?

- Carbon byproduct of conversion process
- Optimal carbonization occurs from 750-1000F
  - Volatiles are removed
  - Pore space is activated
- Fixed carbon + ash
- Highly porous and adsorptive
- No tar filtration

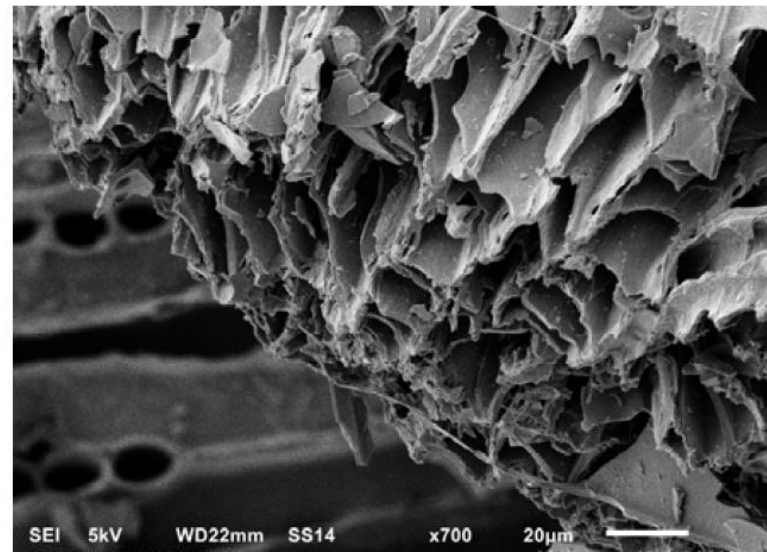


West Biofuels biochar  
from Forest Residue

# Biochar

## Biochar Uses

- Improves soil carbon and overall soil quality
- Increases water retention at the root zone
- Increases nutrient retention, stops leaching
- Increases plant yields
- Usages for filtration
- Usage in asphalt binder
- Publications available at: <http://www.biochar-international.org/biblio>



Biochar Pore Structure



Biochar Crop Trials

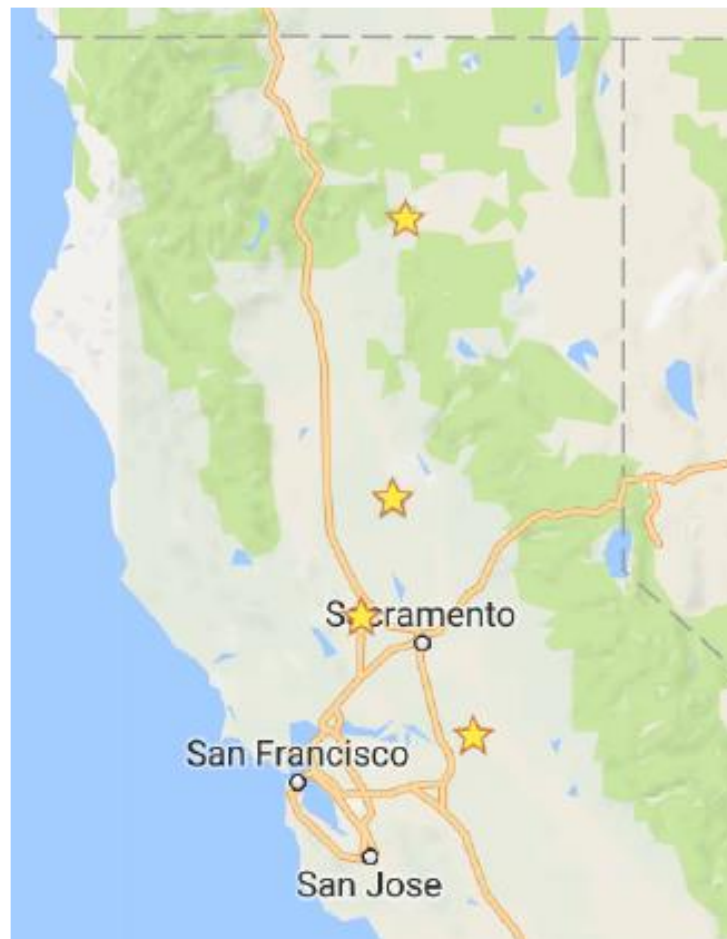
# Biochar

## Biochar market

- Young market with limited supply
- Wholesale:
  - \$250 to \$1,000 per BDT
- Retail:
  - \$0.75 - \$8 per pound (\$1,500 to \$16,000 per ton)
  - Sold across Home Depot, Amazon, Sears, and nurseries

## Examples of Projects Being Developed

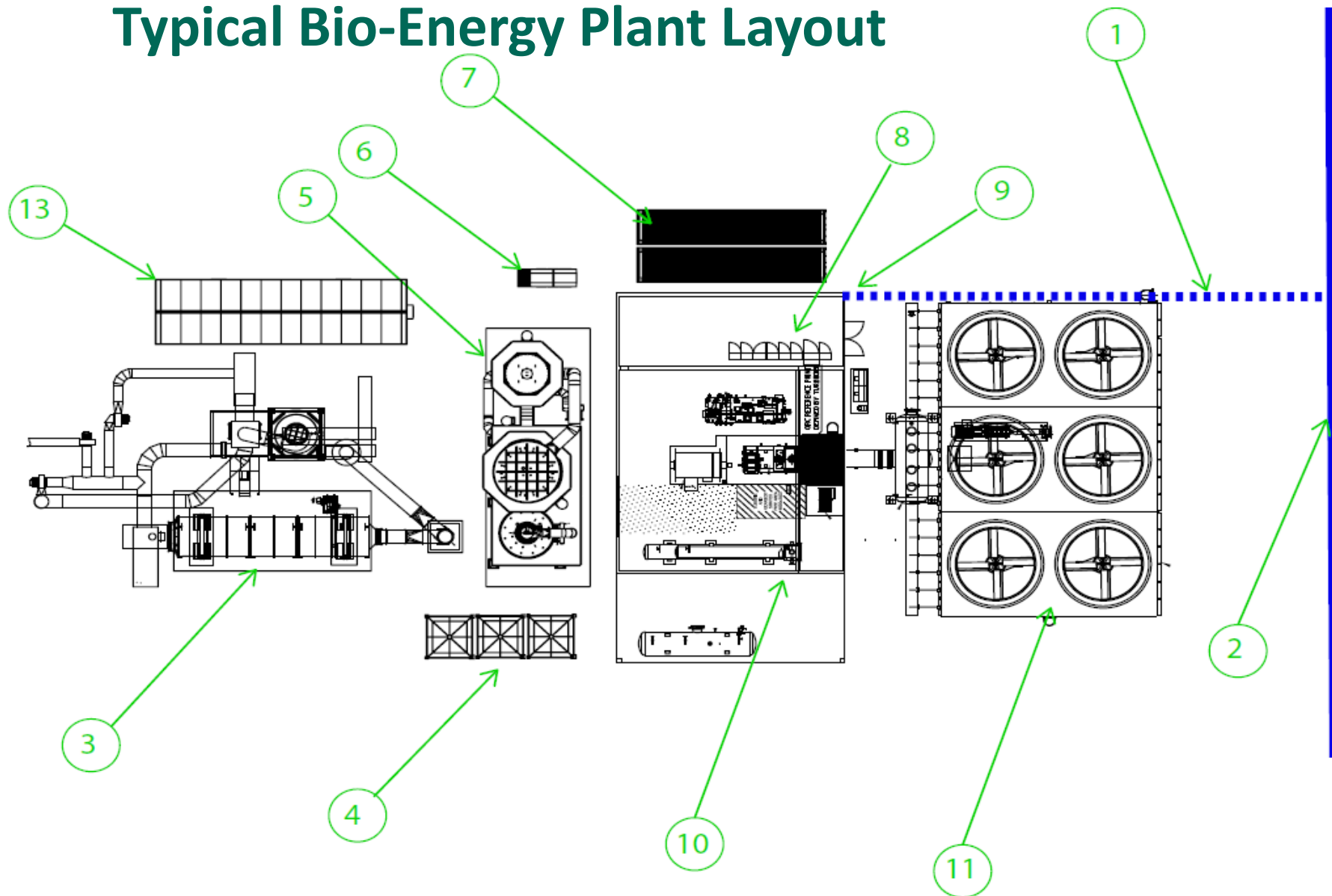
- Forest Thinnings
  - 3 MW of delivered residues
  - Shasta County site
- Almond Hulling Facility
  - 2 MW of on-site shells and 1MW off-site orchard residue
  - Yolo County site
- Rice Milling Facilities
  - 3 MW of on-site rice hulls
  - Sac Valley sites
- Walnut Processing Facility
  - 1.5 MW of on-site shells and 1.5 MW off-site orchard
  - San Joaquin County site



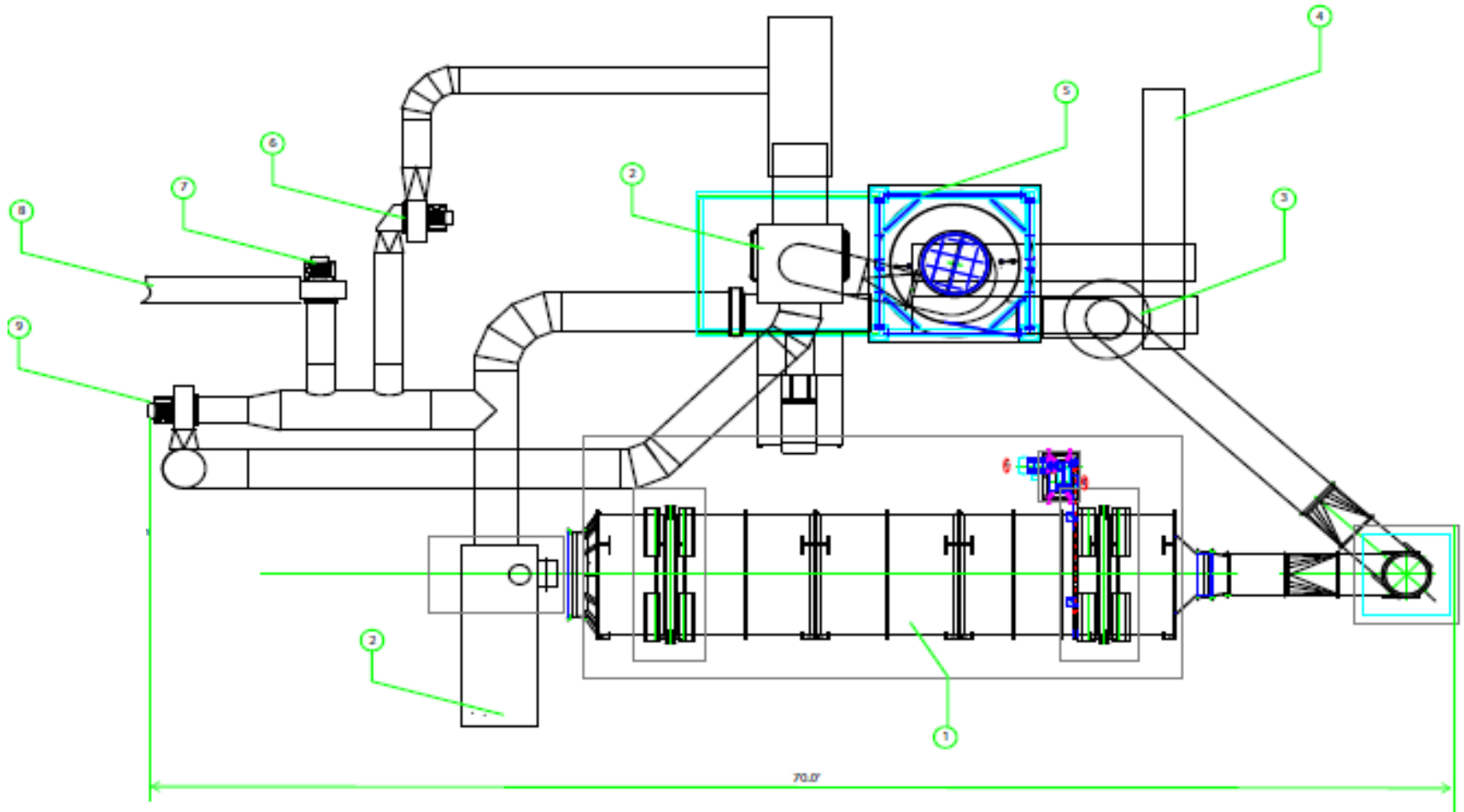
## Technology Advantages

- Trouble-free and automated systems at small scale
- Remote monitoring and maintenance by suppliers
- Biochar production as co-product for added value
- Systems have proven operating histories at this scale
- Modular and scalable to a wide throughput rate
- Ability to increase biomass consumption if needed
- Additional waste heat can be recovered for drying or other combined heat and power projects

# Typical Bio-Energy Plant Layout



# Rotary Gasifier System

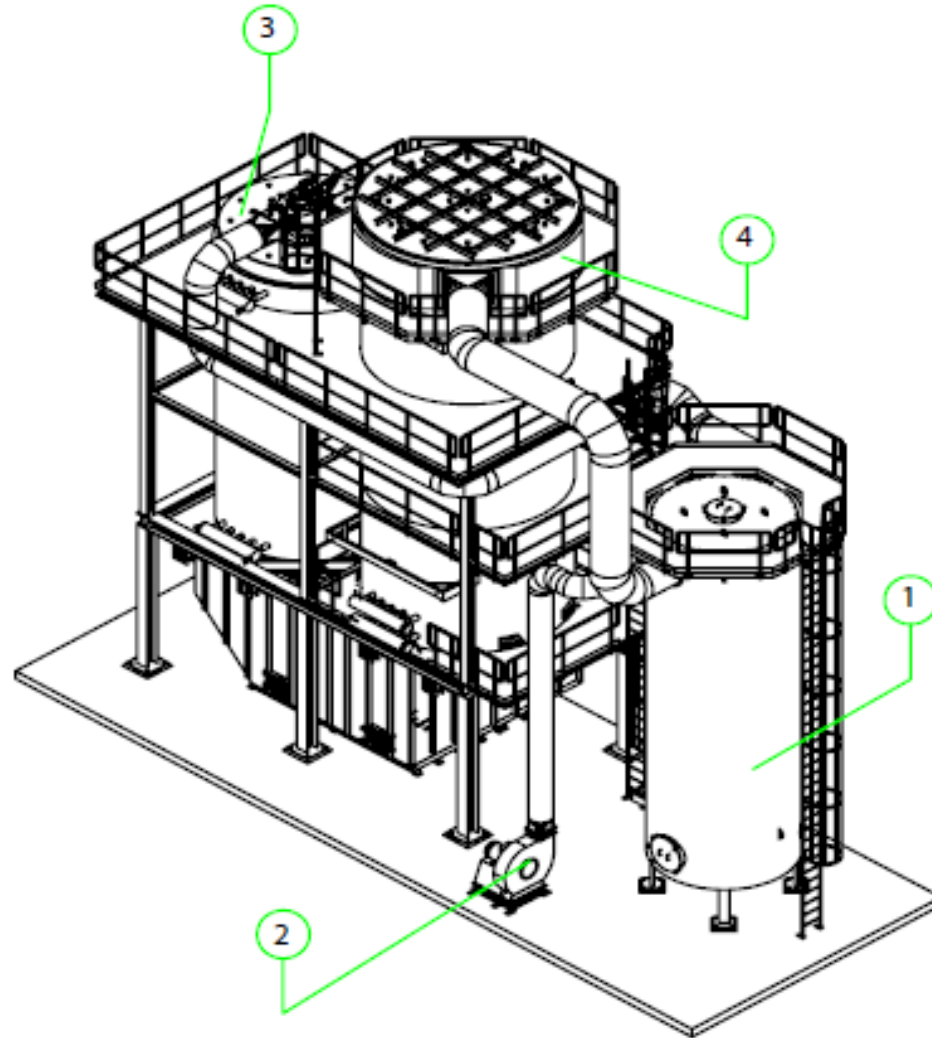


# Rotary Gasifier System





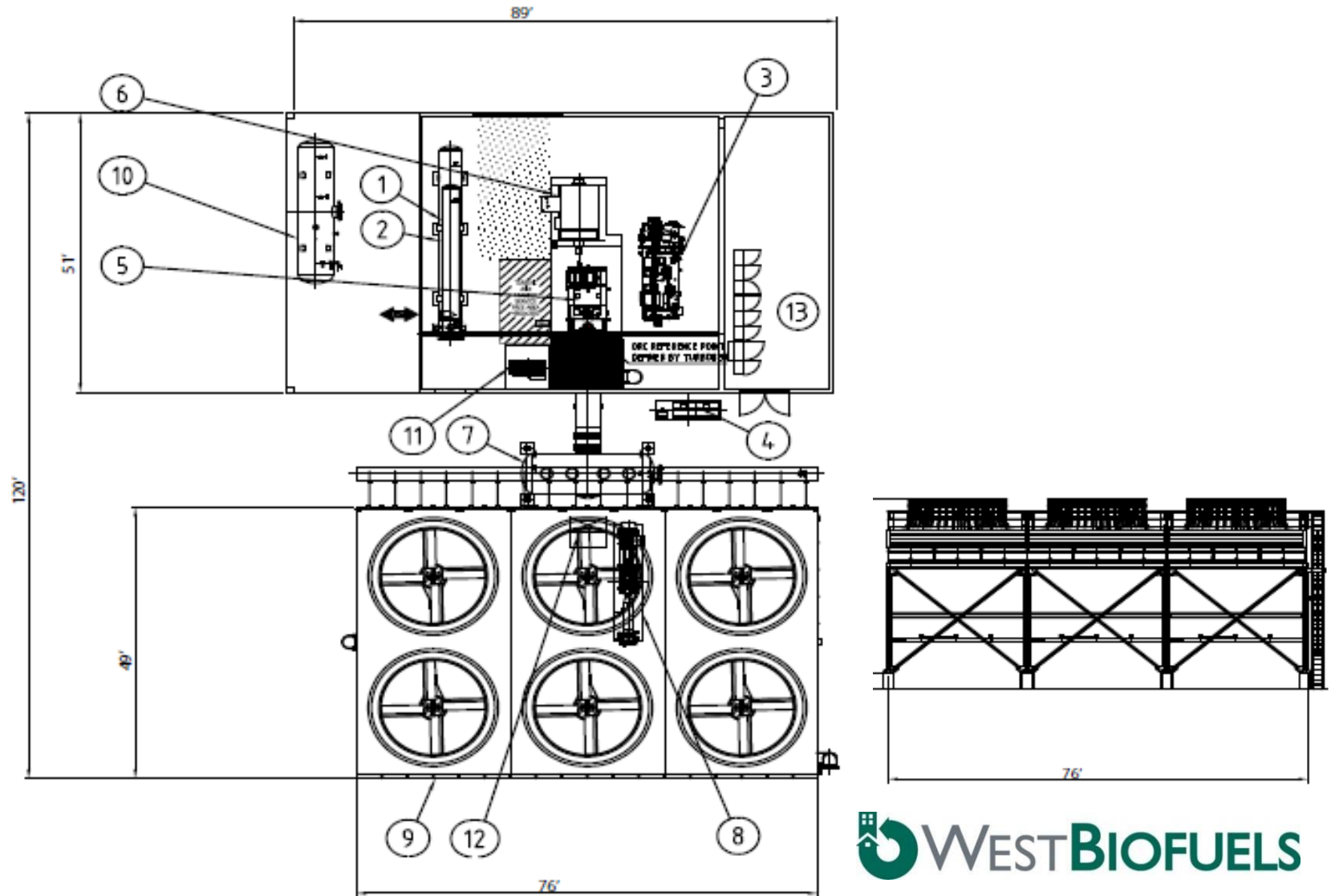
# Thermal Oil Heater System



# Thermal Oil Heater System



# ORC Turbine Generator System and Switchgear



# ORC Turbine Generator System



# Contact West Biofuels

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