

# Integrated Biochar Production System Using Forest Residuals

Measuring performance of a  
biochar machine with belt dryer  
and gasifier generator set

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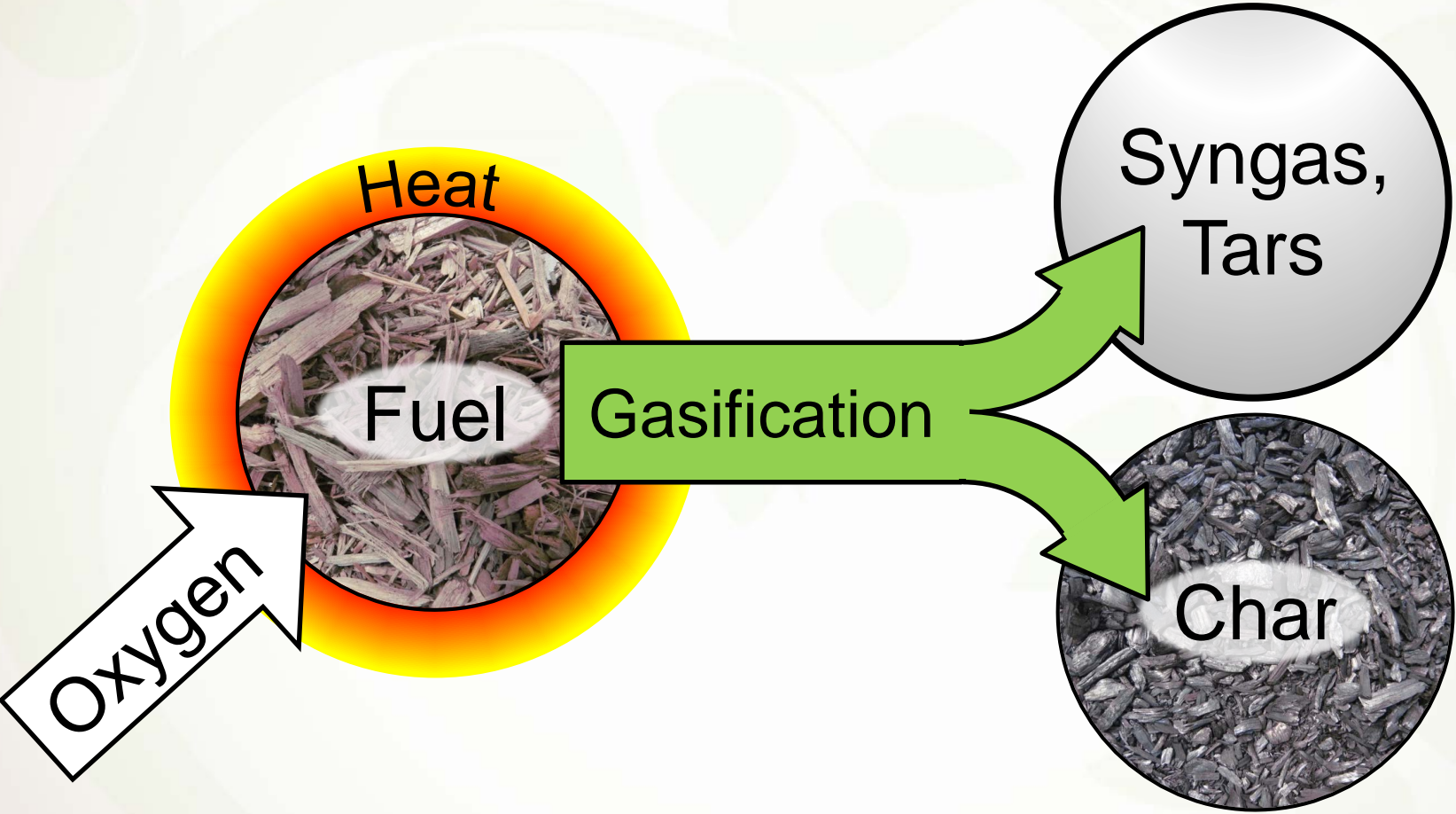
# Presentation Outline

- » Background
  - » Biochar Production Process
  - » Technology Description
- » Adding Waste Heat Recovery Dryer
  - » Test Objectives
  - » Results
- » Integrated Biochar Production System
  - » System Overview
  - » Results
- » Conclusions



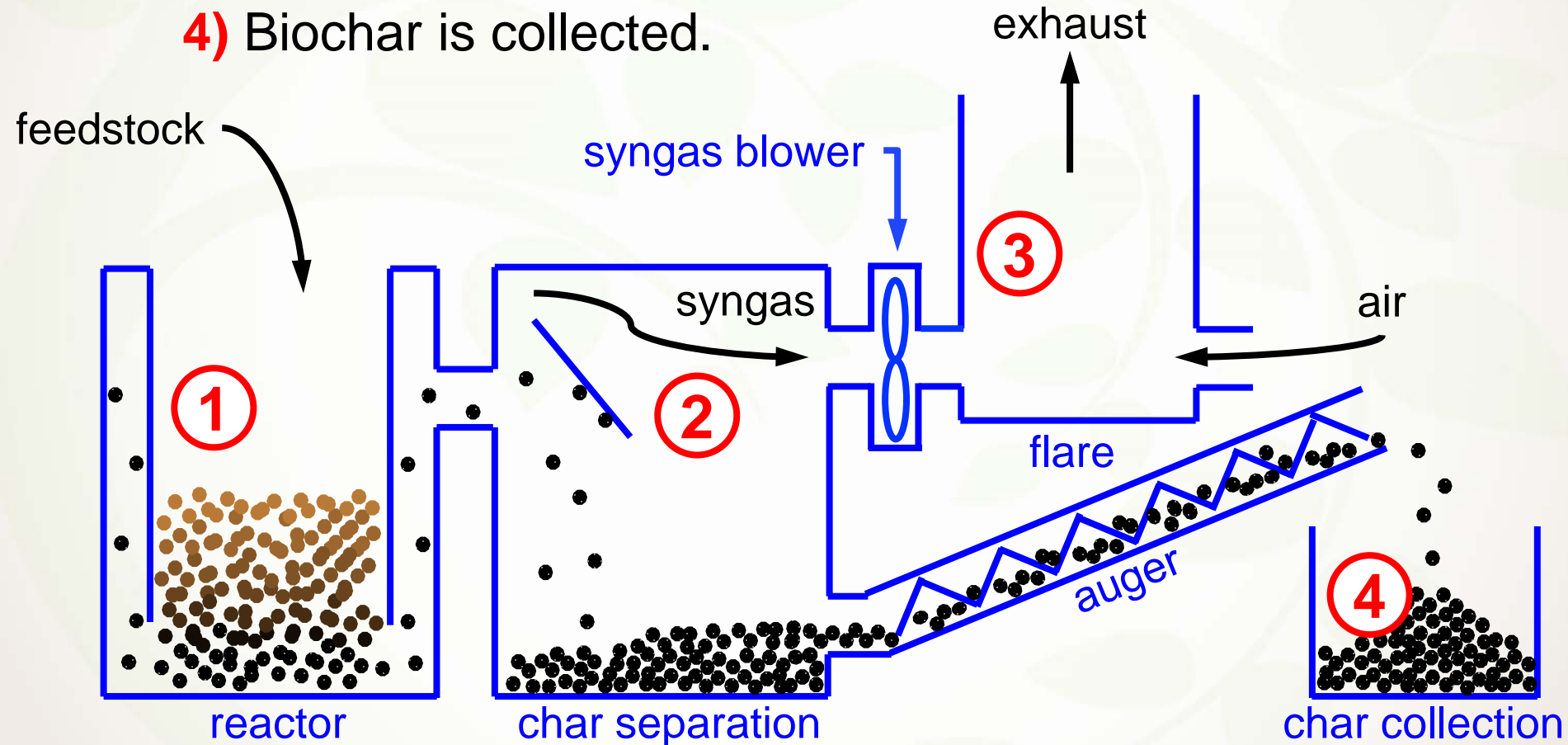
# Biochar Production

Biochar is produced through thermal decomposition of biomass in an oxygen-limited environment, a process known as gasification.

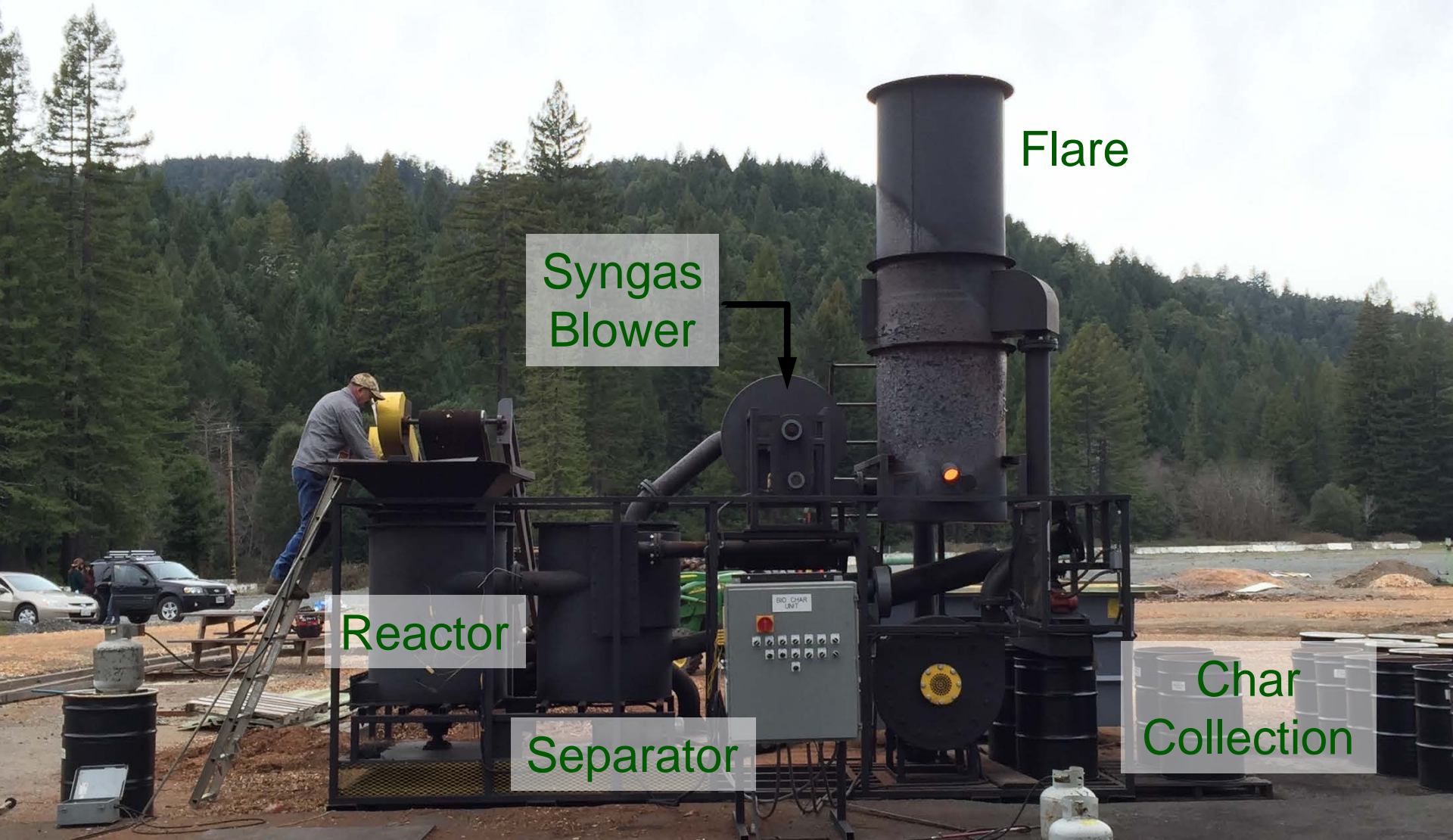


# Process Diagram for Biochar Solutions, Inc. Machine

- 1) Biomass undergoes gasification in the reactor.
- 2) Char is separated from the syngas.
- 3) Syngas is burned in a flare.
- 4) Biochar is collected.



# Biochar Process Flow



Flare

Syngas  
Blower

Reactor

Separator

Char  
Collection

# Feeding System for Biochar Machine



Feedstock Hopper

Conveyor

Reactor

# Lessons Learned from Testing this Machine

## Lesson

» Moisture content of the feedstock greatly impacts production rates and labor costs.

» A reliable power source is required to operate at remote locations.

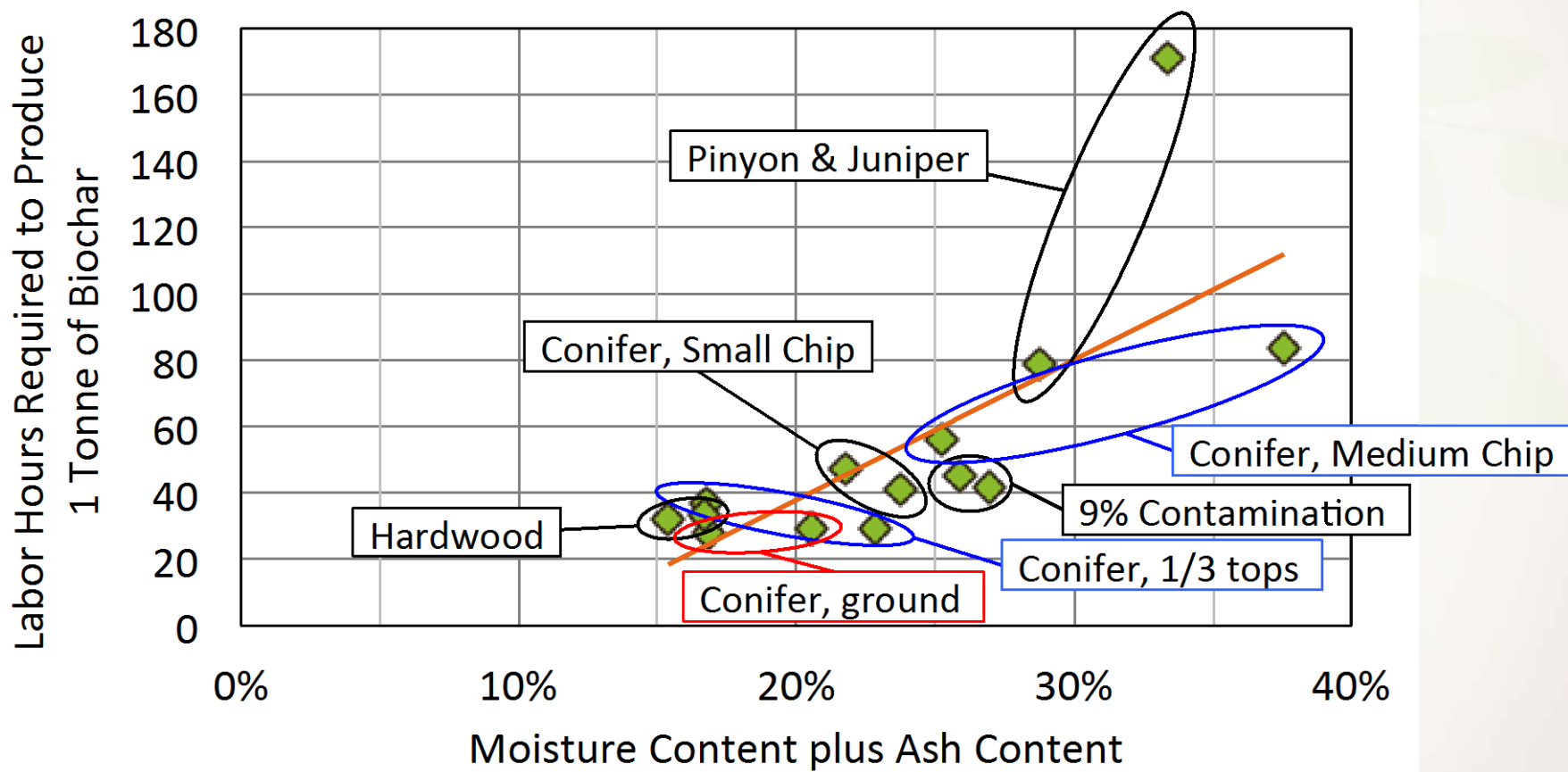
## Proposed Solution

» Utilize waste heat from flare to dry incoming feedstock

» Assess suitability of biomass gasifier generator set to power biochar machine

# Moisture Content is an Economic Driver

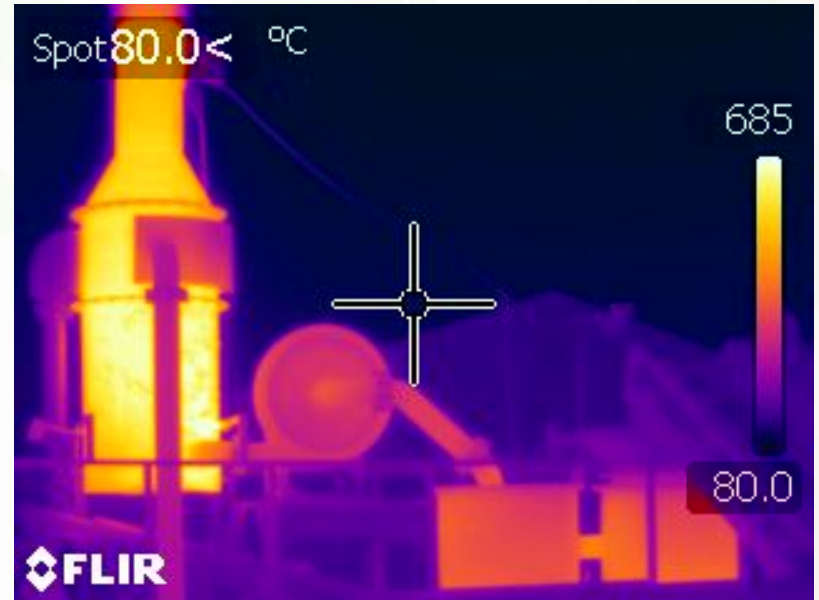
During testing of this machine in 2014, moisture content was found to greatly influence labor hours and operational costs.





# Waste Heat Recovery for Feedstock Drying

- » The biochar flare is a significant source of high quality waste heat.
- » This heat can be used as the input to a belt dryer.
- » If successful, this could increase the range of acceptable moisture contents, and decrease the operational effort of the biochar machine.



# Electricity Generation from Biomass Side Stream

- » Biomass is readily available on location
- » Power can be generated from a side stream of biomass to offset diesel costs
- » A small gasifier generator can meet the electrical demand



# Gasifier Technology Description

All Power Labs, Inc. PP20 Gasifier

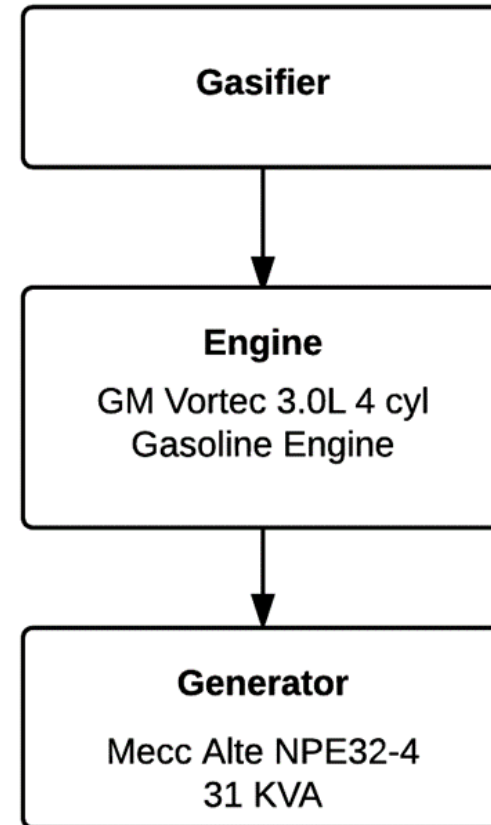


Image from All Power Labs, Inc.

# Dryer Study

## Installation

- » Install heat exchange equipment.
- » Instrument the dryer with temperature, relative humidity, flow rate, and power meters.
- » Automate the conveyance system from dryer inlet to biochar production.

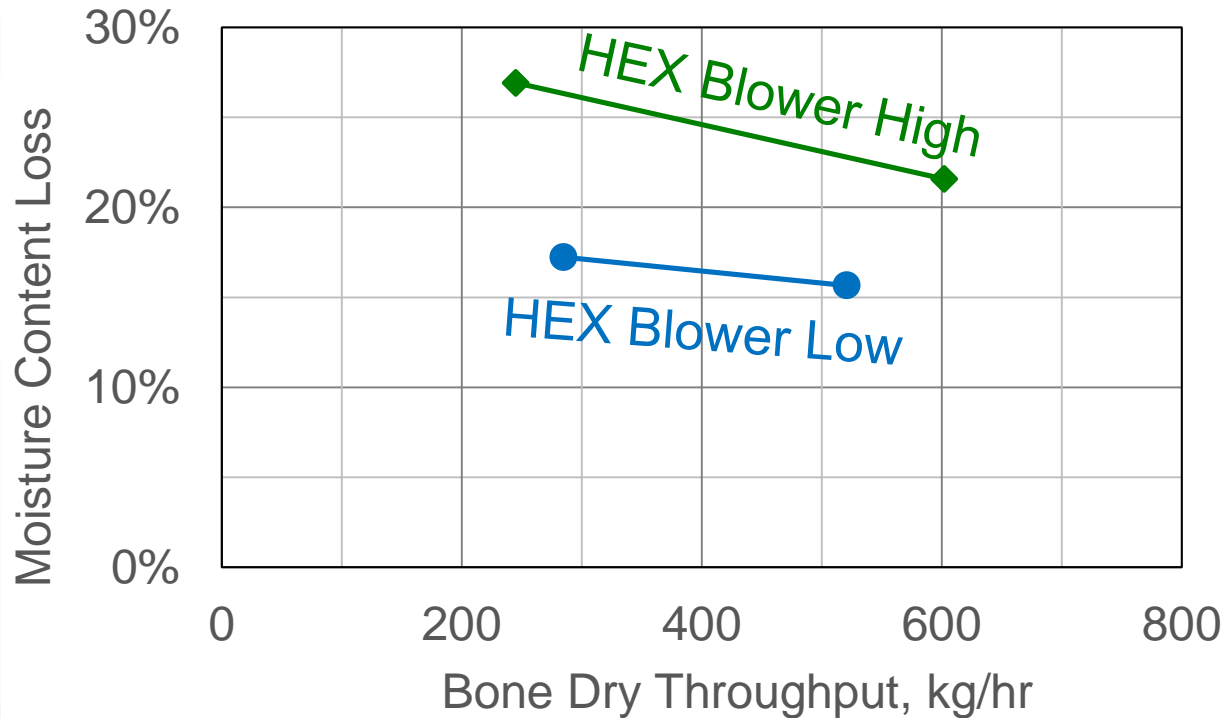
## Test Objectives

- » Determine best operating conditions for dryer by changing:
  - » Hot air flow rate and temperature
  - » Dryer belt speed and capacity



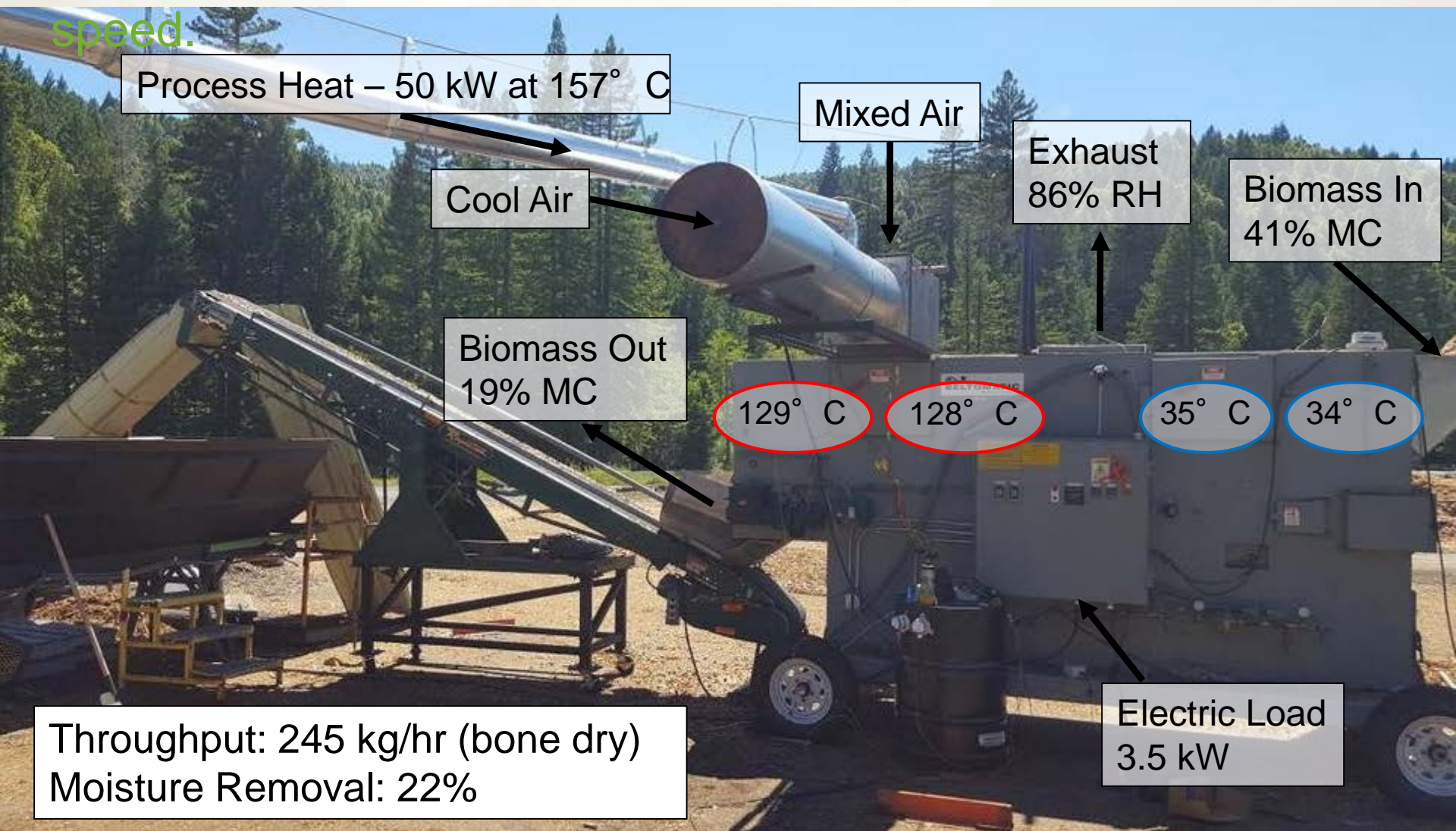
# Dryer Study: Results

- » Tested two heat exchanger (HEX) blower speeds; higher flow → lower temperature
- » Tested two dryer belt speeds; higher belt speed → higher throughput
- » Best drying achieved at high blower speed.
- » Adjust dryer belt speed to match consumption rate of biochar machine.



# Dryer Operating Conditions

Process conditions at high HEX blower, high belt speed.



# Project Objectives for Integrated Operation

- » Using information from the dryer study, and integrated system was setup to operate the biochar machine.
- » The biomass gasifier generator was connected to the system to validate its performance.

## Objectives

- » Determine system throughput during 8 hours operation.
- » Measure labor requirements



# Integrated System Background Information

**Biochar Machine:** Biochar Solutions, Inc.

**Gasifier Generator:** 20 kW PP20, All Power Labs, Inc.

**Dryer:** 123B Belt-o-matic, Norris Thermal Technologies

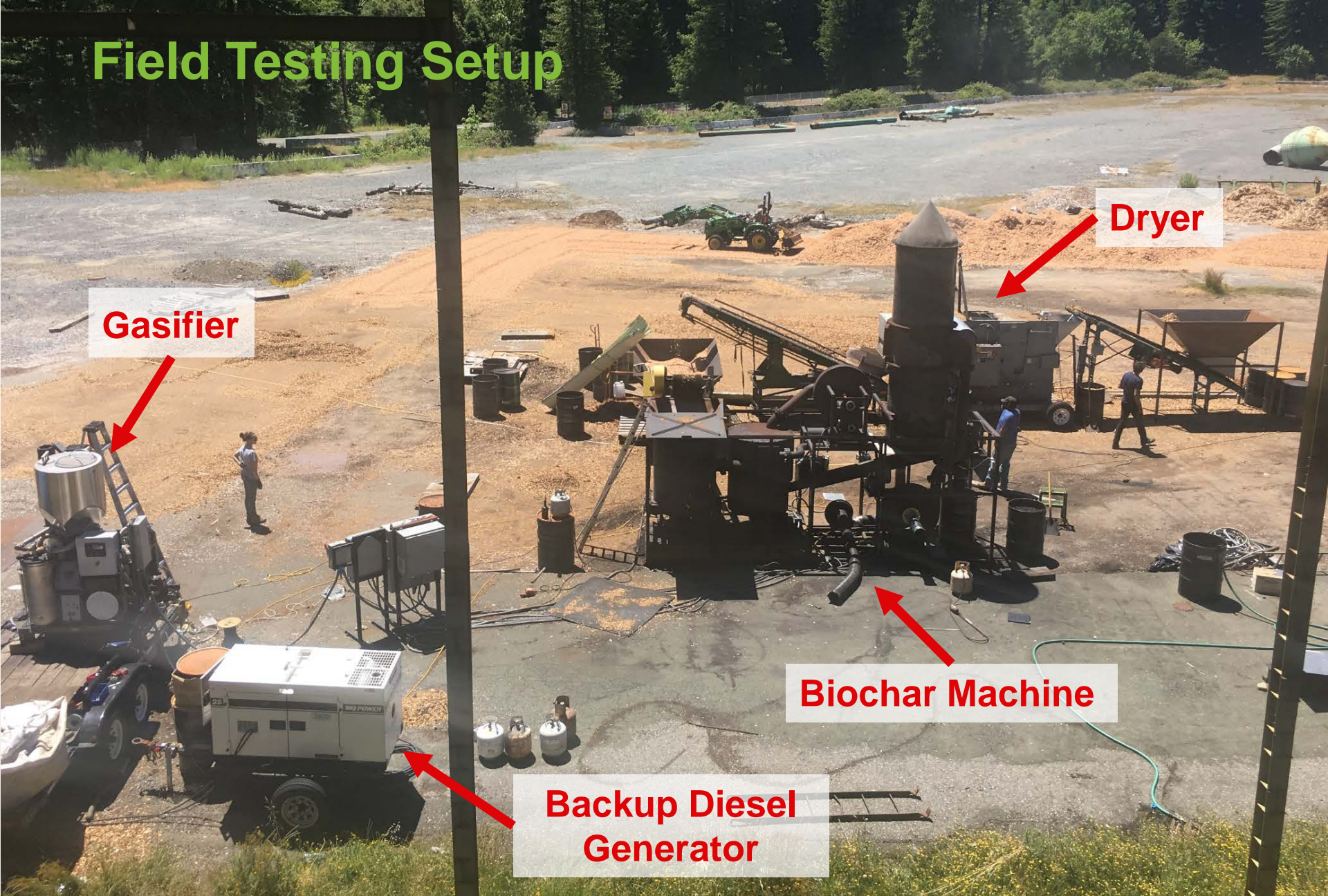
**Date:** June 2016

**Location:** Old Harwood Mill in Branscomb, California

**Feedstock:** Green Redwood Chips



# Field Testing Setup



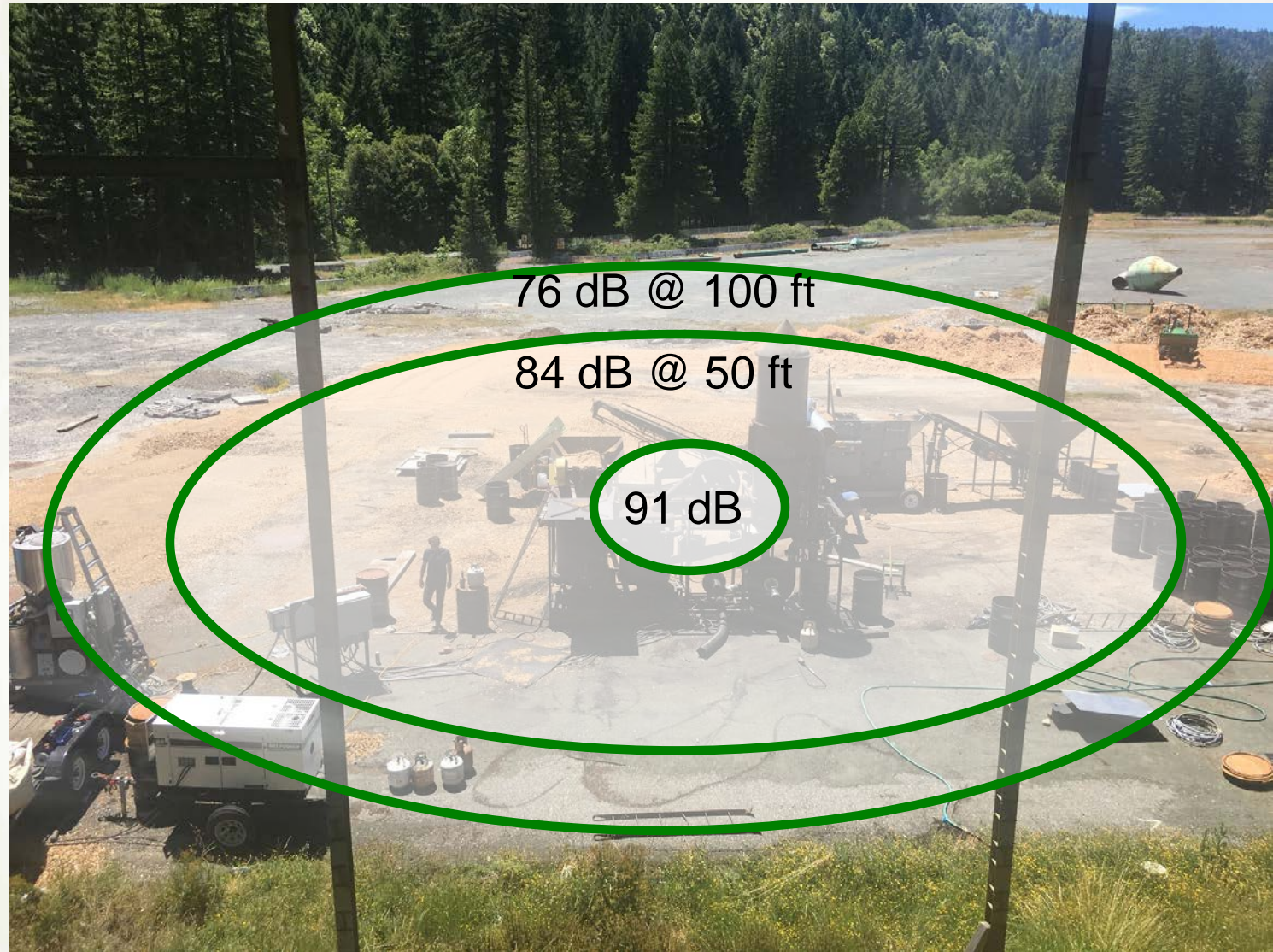
**Gasifier**

**Dryer**

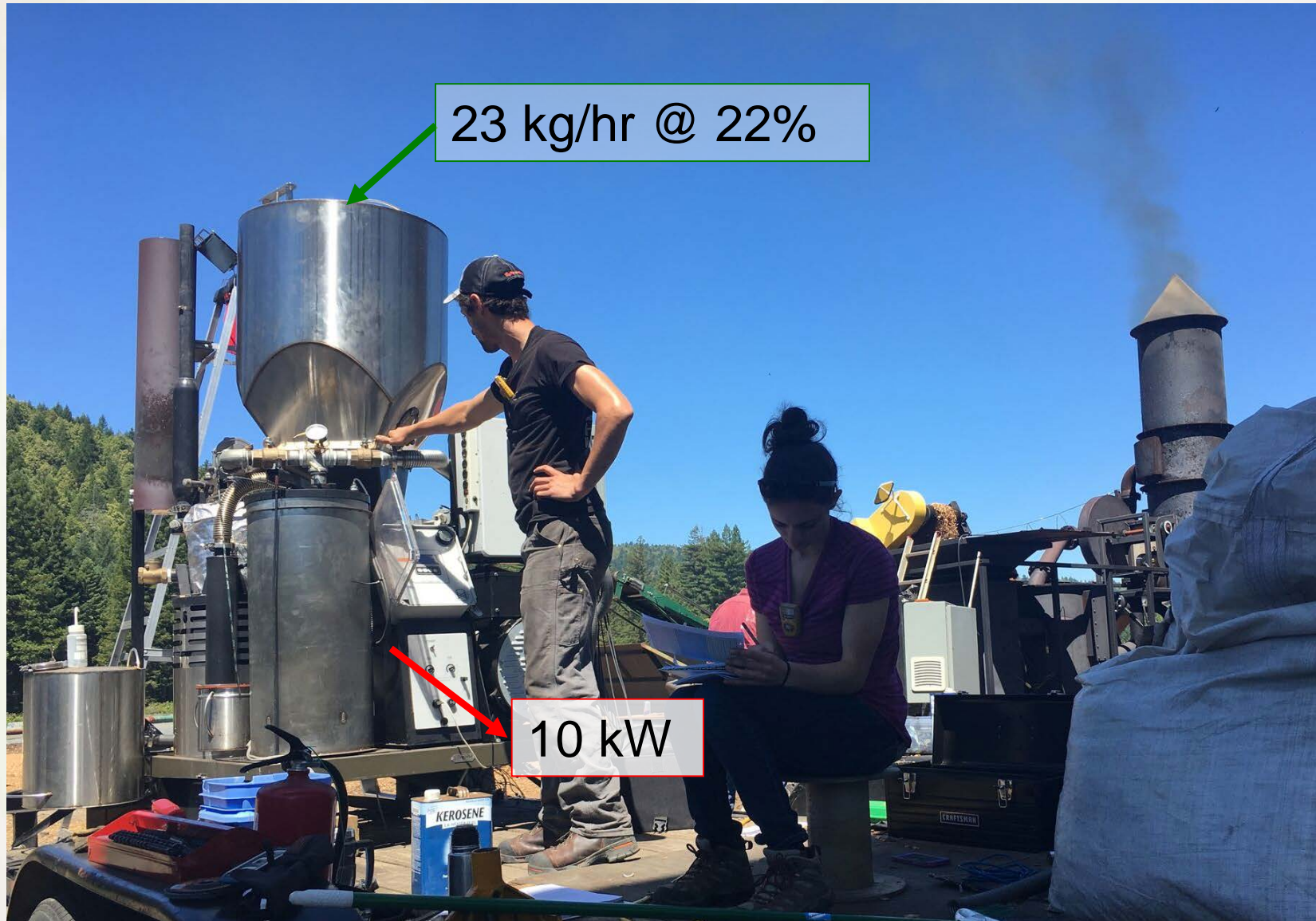
**Biochar Machine**

**Backup Diesel  
Generator**

# Integrated Operation Noise Level

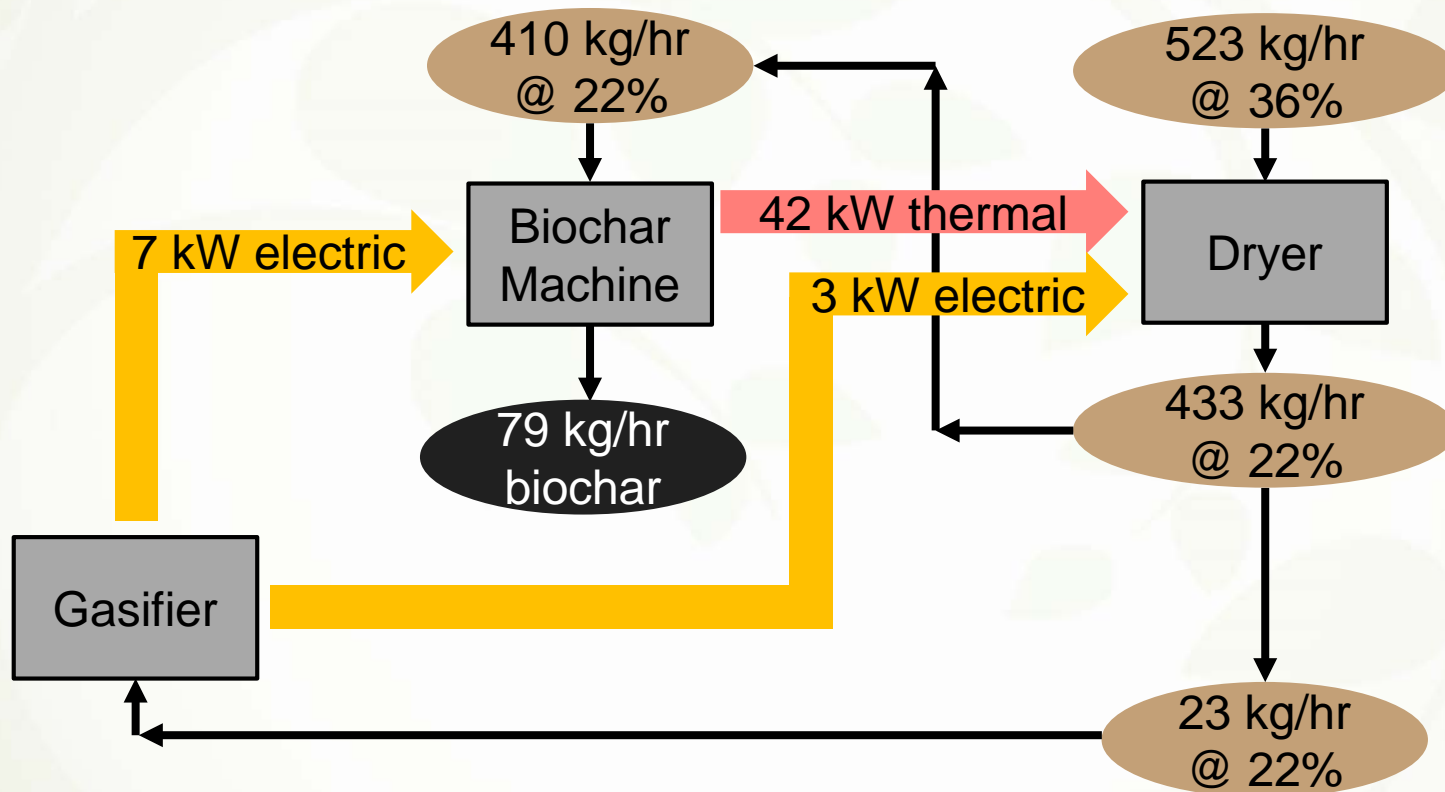


# Gasifier Process Flow



# System Integration Flow Diagram

» Mass and energy flows during the test are shown below



# Benefits of System Integration

## Increase Range of Acceptable Moisture Contents

- » Utilize waste heat to dry incoming feedstock.
- » Without dryer, maximum moisture content was 25%
- » With the dryer, incoming moisture content can be up to 40%

## Electricity Usage

- » The biochar machine uses 107 kWh<sub>e</sub> to produce 1 ton of biochar.
- » Gasifier generator can offset diesel fuel by using a sidestream of biomass feedstock.

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	Diesel Generator	Biomass Gasifer
Fuel Rate at 9 kW load	0.9 gal/hr	18 kg/hr (dry basis)
Fuel to Produce 1 ton Biochar	10.4 gal	205 kg (dry basis)

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# Conclusions

- » Belt dryer works well with waste heat from flare, can remove up to 25% moisture.
- » Integrating belt drying into system increases the acceptable moisture content of the biochar machine from 25% to 40%.
- » The gasifier generator can meet the electrical demand of the system with additional maintenance costs.

