



Agricultural Bioenergy and Biochar: Elements of a Successful Project

**CENTRAL VALLEY SUMMIT
ALTERNATIVES TO OPEN BURNING OF AGRICULTURAL WASTE**

November 8, 2017

Company Profile

What?

- Biomass thermochemical conversion technology provider

Why?

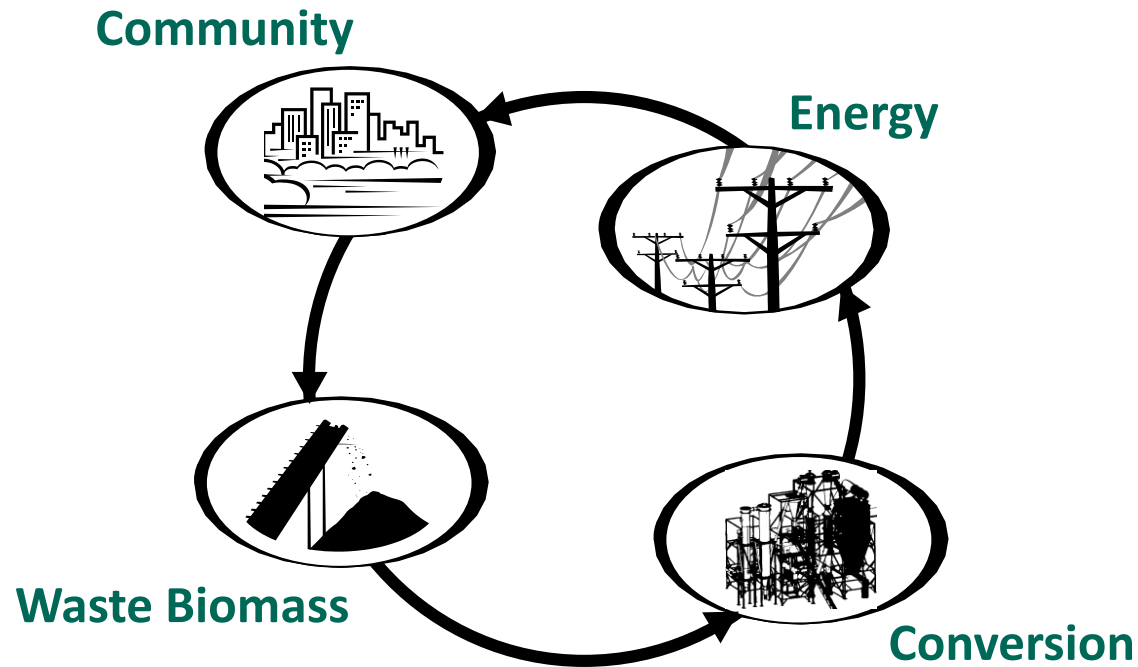
- Biomass will continue to be made
- New and innovative approaches to creating reliable, value-added products are needed

Where?

- Fabrication & Testing Facility in Woodland

West Biofuels Mission

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



Agricultural Feedstock

Shells



Hulls



Prunings



Removals



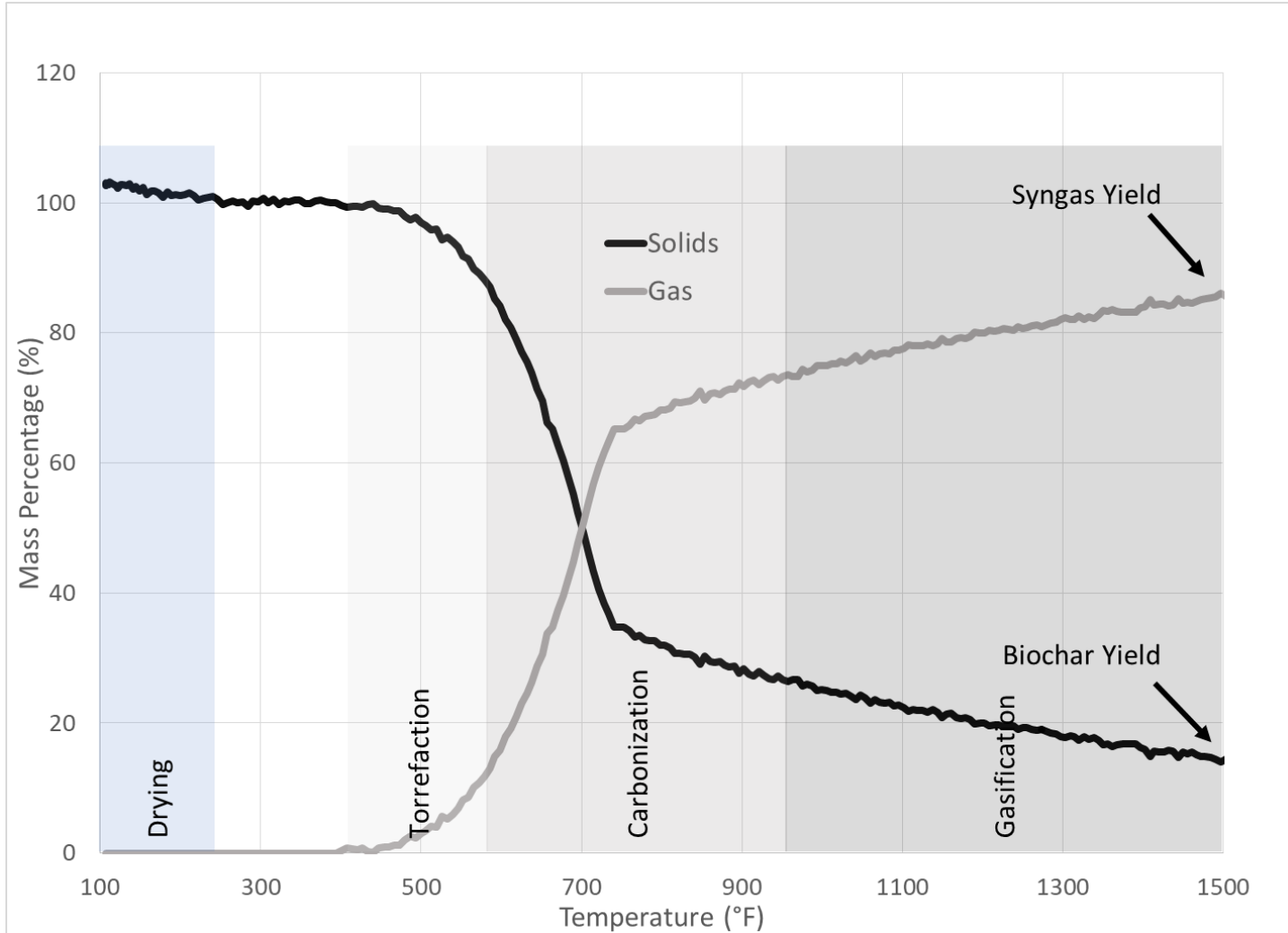
Stalks

Feedstock

- Specifically engineered for a target feedstock blend
- Variations controlled by operating parameters
- High level of flexibility

Feedstock Type	Average Ash Content
Almond Shell	3.62%
Pre-Mix Hulls	7.73%
Pollinator Hulls	7.85%
Nonpareil Hulls	7.70%
Almond Wood	2.17%

Feedstock Conversion



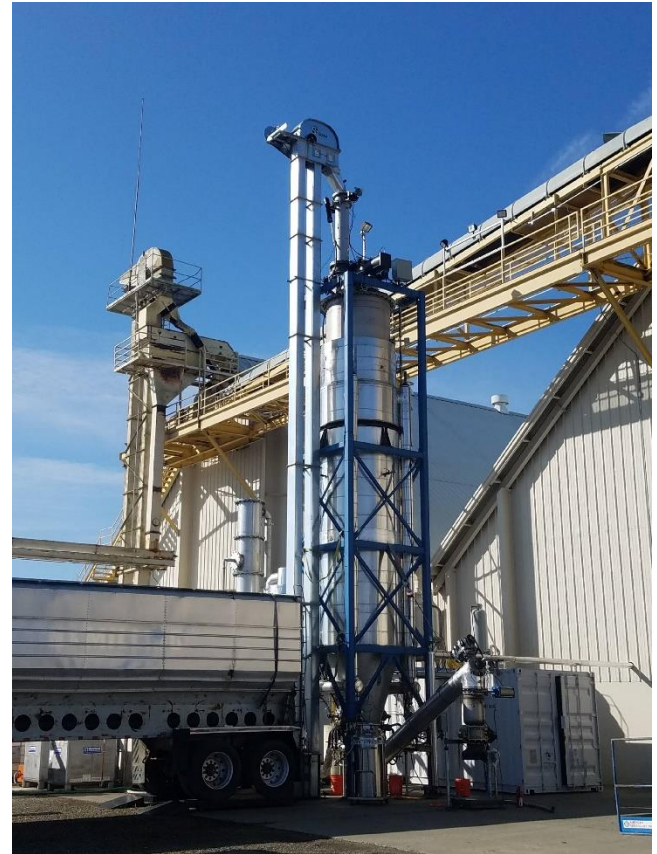


FICFB Gasifier



Rotary Gasifier

Gasification Technologies



CircleDraft Gasifier

Generator Technologies



Rich Burn IC Engine



Lean Burn IC Engine



ORC Turbine

Opportunity

- Current markets
 - No long term off-take agreements (<\$0 to \$30/BDT)
 - Closing and ageing conventional biomass plants
 - Prohibition/restriction of open burning
- New markets – Bioenergy + Biochar
 - Electricity: \$187/MWh
 - ~ \$125/BDT of feedstock revenue potential
 - Biochar: \$250 - \$2,000+/BDT of biochar
 - ~\$40 - \$300/BDT of feedstock revenue potential
 - Total Potential: **\$165 - \$425/BDT of feedstock**

Opportunity

- Biomass Market Adjusting Tariff (BioMAT)
 - Offers 10, 15, or 20 year power purchase agreements (PPA)
 - 3MW or smaller size – designed to fit biomass supply and on-site interconnection
 - Contracts are available for procurement until December 2020.
- Current agriculture price is \$187/MWh (\$0.187/kWh)

Biochar

What is biochar?

- Carbon byproduct of thermochemical conversion processes
 - Torrefaction: 425-575F
 - Carbonization: 575-950F
 - Gasification: >950F
- Fixed carbon + ash
- Highly porous and adsorptive

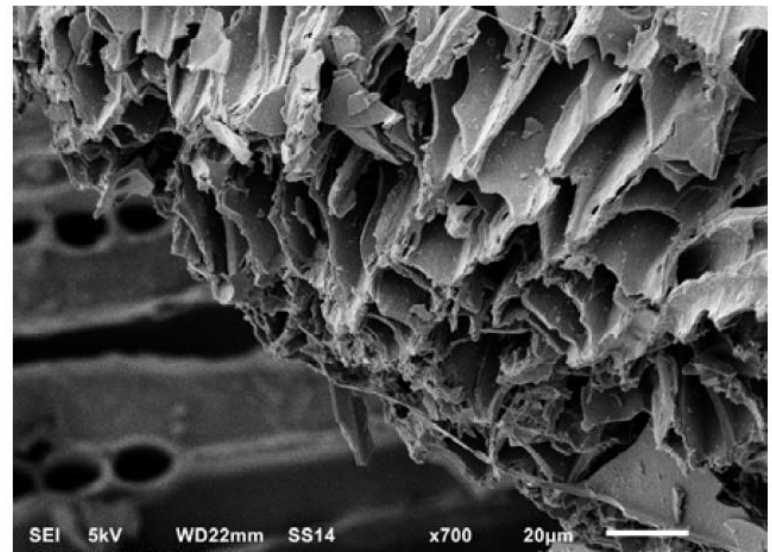


West Biofuels biochar
from Forest Residue

Biochar

Why biochar?

- Improves the quality of the soil
- Increases water retention at the root zone
- Increases nutrient retention, stops leaching
- Increases plant yields
- Usage for boundary filtration of contaminants
- Publications available at: <http://www.biochar-international.org/biblio>



Biochar Pore Structure



Biochar Crop Trials

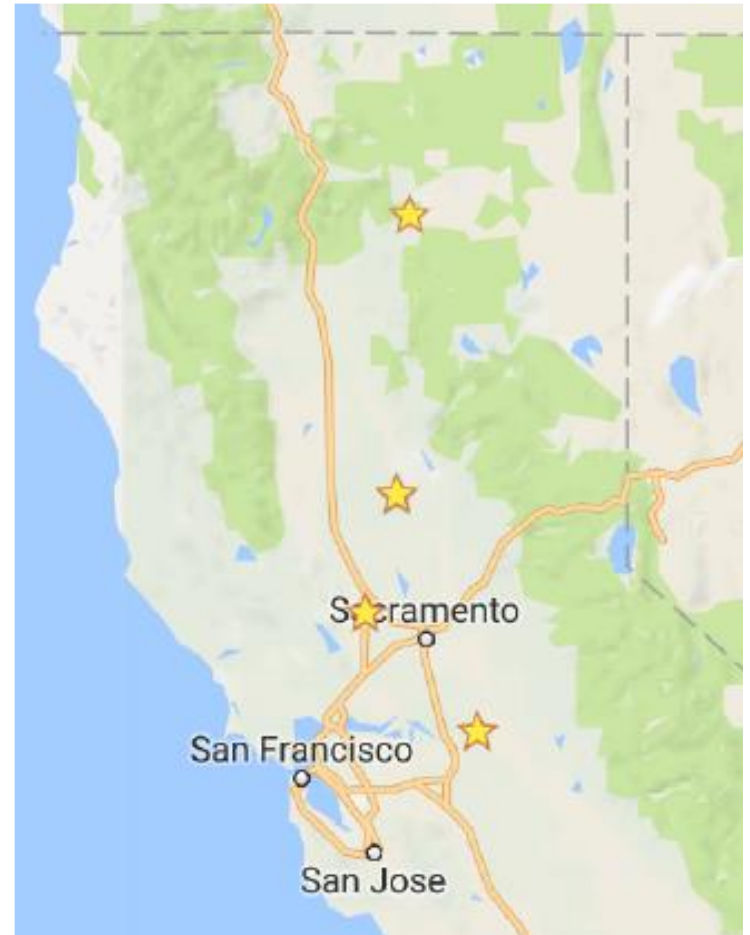
Biochar

Biochar market

- Young market with limited supply
- Wholesale:
 - \$250 to \$2,000+ per BDT
- Retail:
 - \$0.75 - \$8 per pound (\$1,500 to \$16,000 per ton)
 - Sold across Home Depot, Amazon, Sears, and nurseries

Projects Being Developed

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

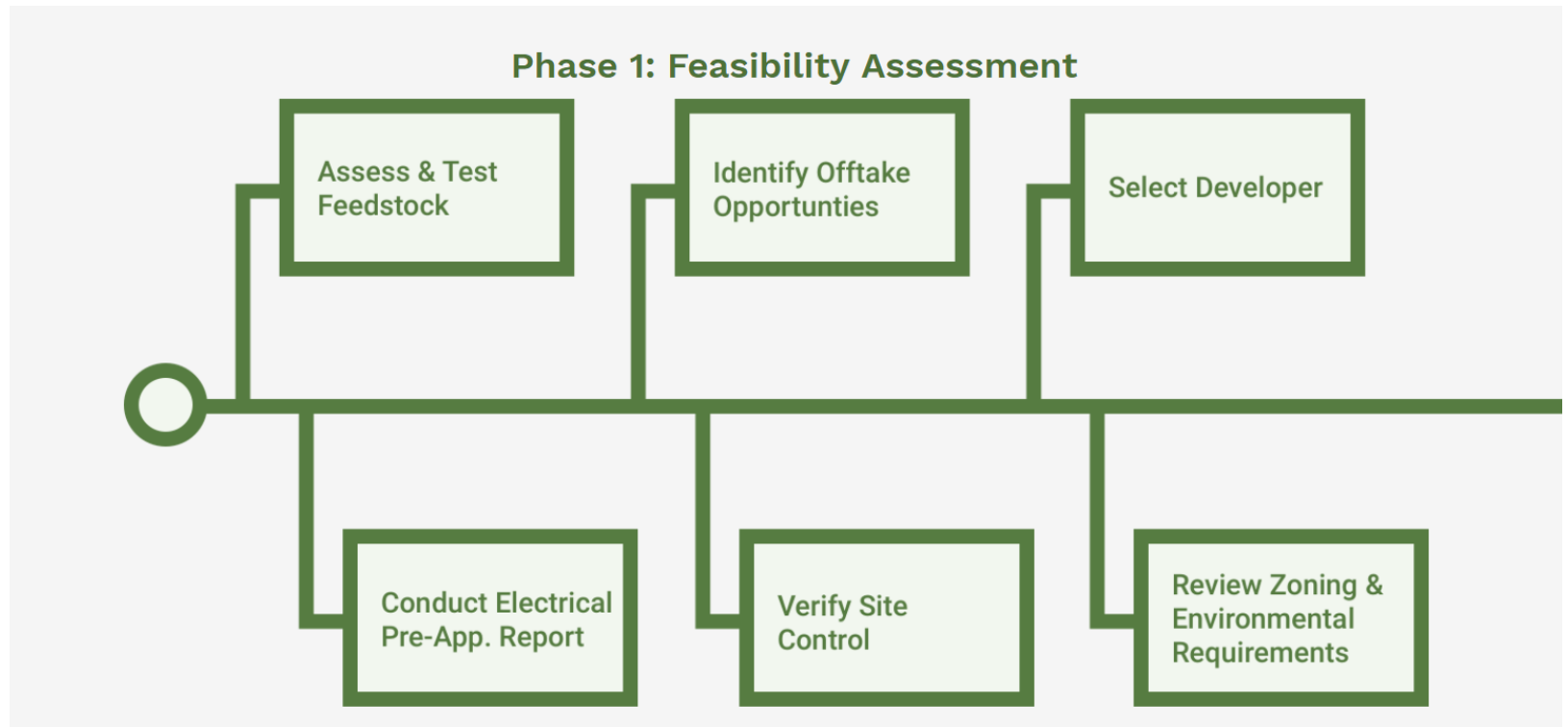


COMMERCIAL PROJECT EXAMPLE:

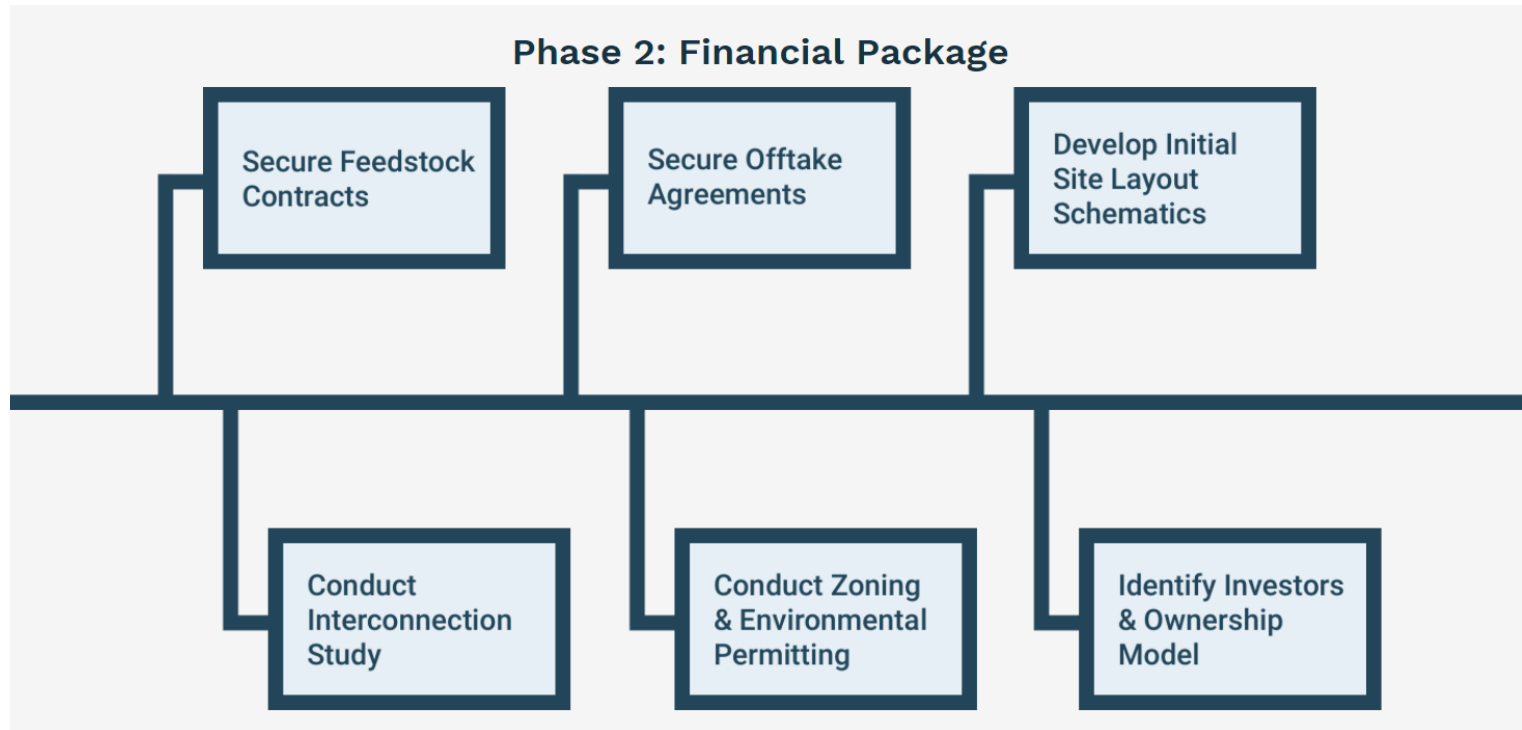
3MWe Ag Biopower & Biochar Facility

- Concept: Ag BioMat PPA and available shell and residues
- Physical Plant: Feedstock Handling, Rotary Gasifier, TO Heater, ORC Generator with Switch Gear, Emissions Controls
- Input: 38,000 tons per year - 50% shell/50% wood (12%mc)
- Output: 23,000 MWh & 7,500 tons biochar per year
- Online time: 320 days per year
- Lifetime – Carbonizer/Gasifier plus Peripherals: 20+ years
- Lifetime - ORC Generator: 20+ years
- Revenue: \$6.5M per year
- Capital Cost: ~\$15M
- ROI – 20%

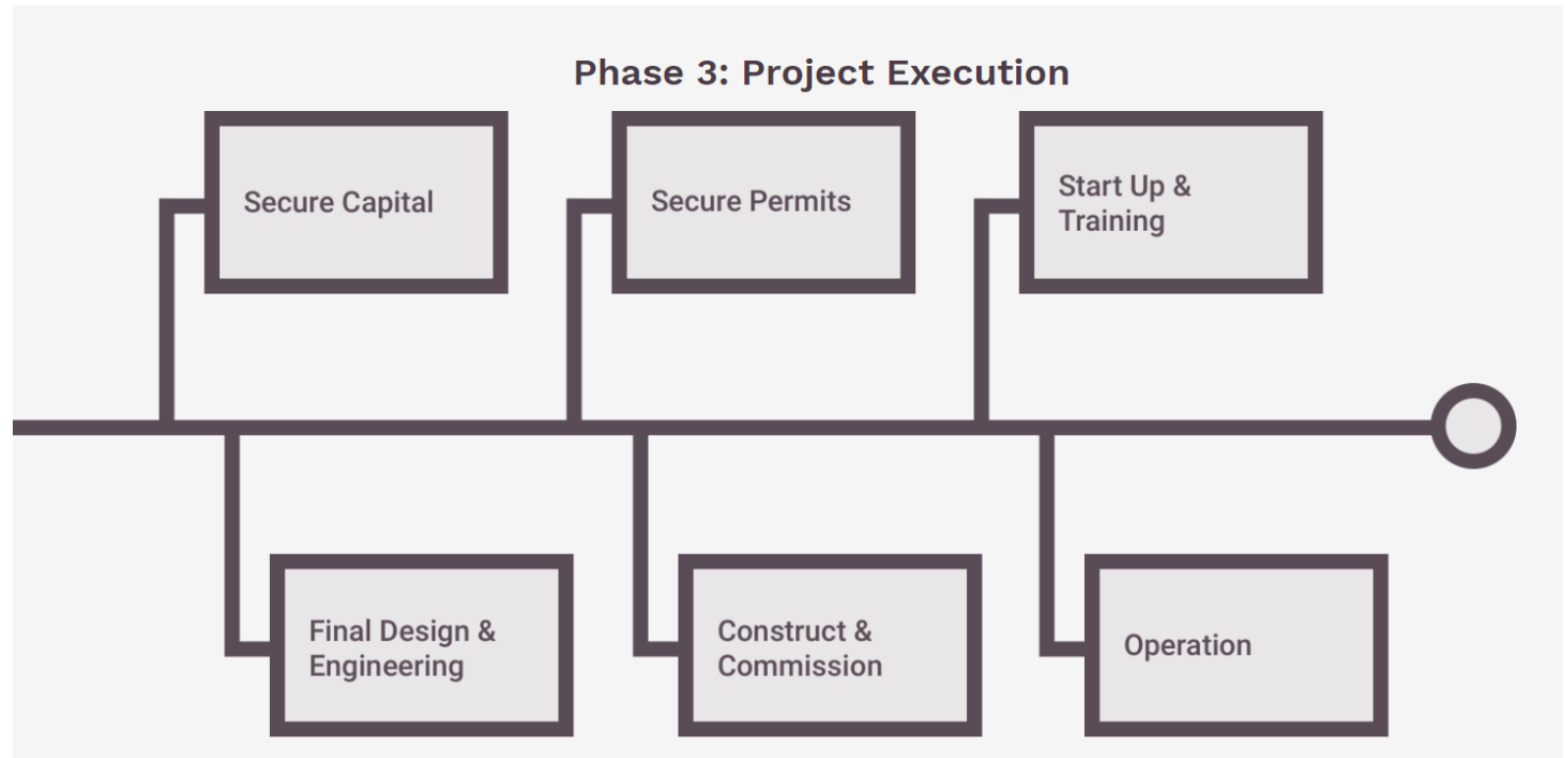
Biomass Project Development Steps



Biomass Project Development Steps



Biomass Project Development Steps



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