Forest Energy

# $CO_2$ Neutral Energy + Carbon Sink using Local Biomass

FOREST ENERGY, INC
Founder and CEO, Shingo Numa

# Today's topic



① Introduce "carbon negative" power plant, using gasification CHPs

② Show examples of our small biomass CHPs in Japan

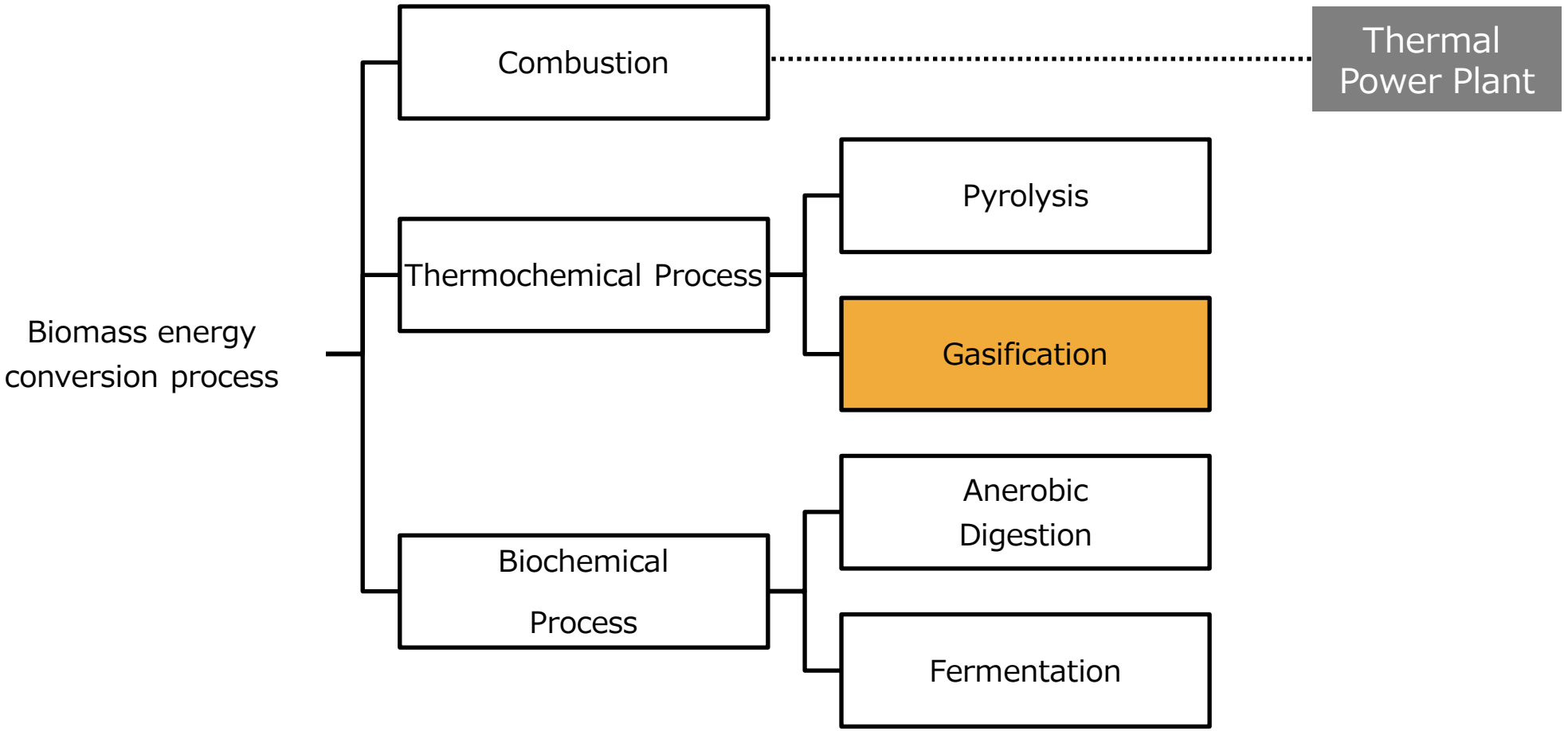
③ Business model example of "CHP x Biochar"

④ Announcement: Host a webinar, as next step

# Converting Biomass into Energy



- Three process to convert biomass to energy
- When biomass is combusted (burned), STEAM is produced to generate ELECTRICITY or HEAT
- Today, we focus on thermochemical process called GASIFICATION

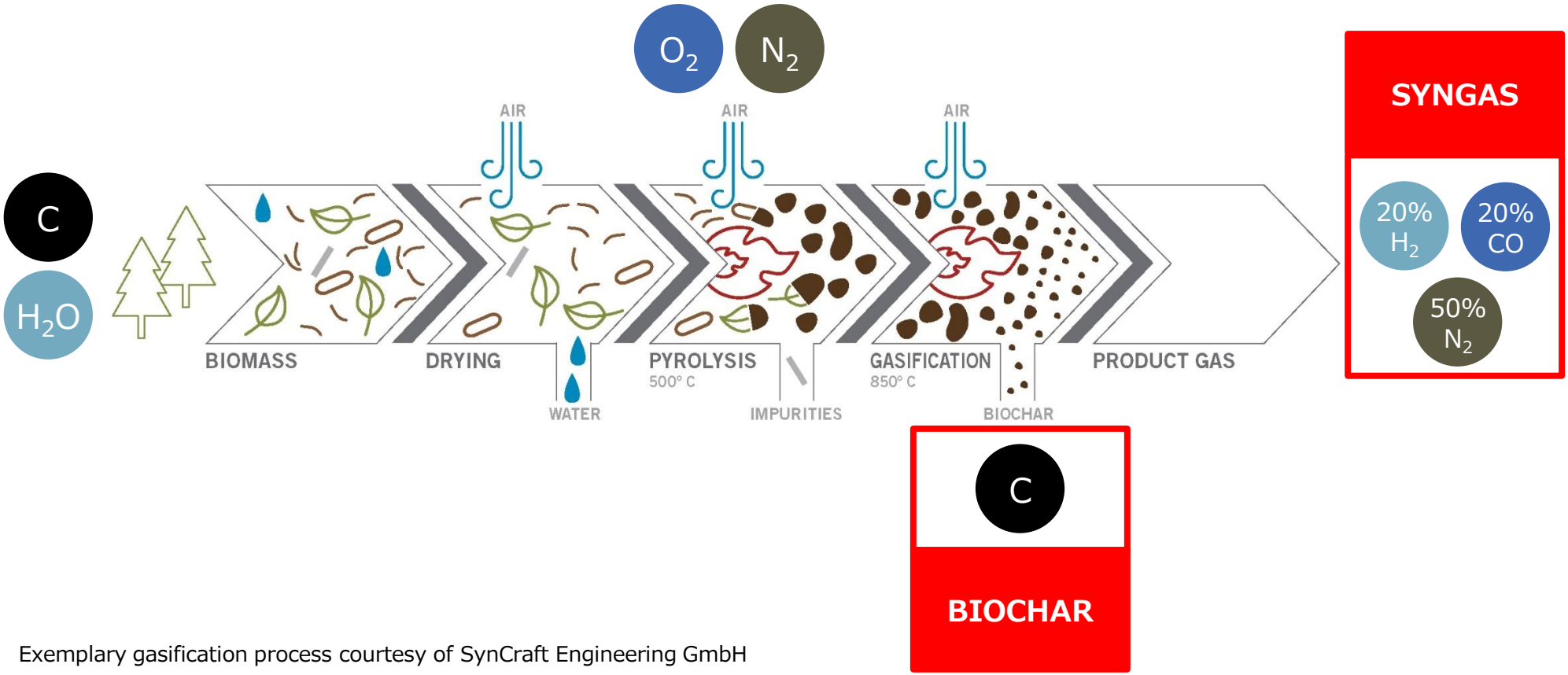


# Biomass Gasification Technology



- By heating biomass at high temperature without oxygen, biomass is converted into SYNGAS (energy gas, product gas)
- This process is called PYROLYSIS or GASIFICATION
- Byproduct of energy is BIOCHAR (carbon)

## PROCESS FLOW OF GASIFICATION




Exemplary gasification process courtesy of SynCraft Engineering GmbH

# Using Biomass to Create “Carbon Negative” Power Plant

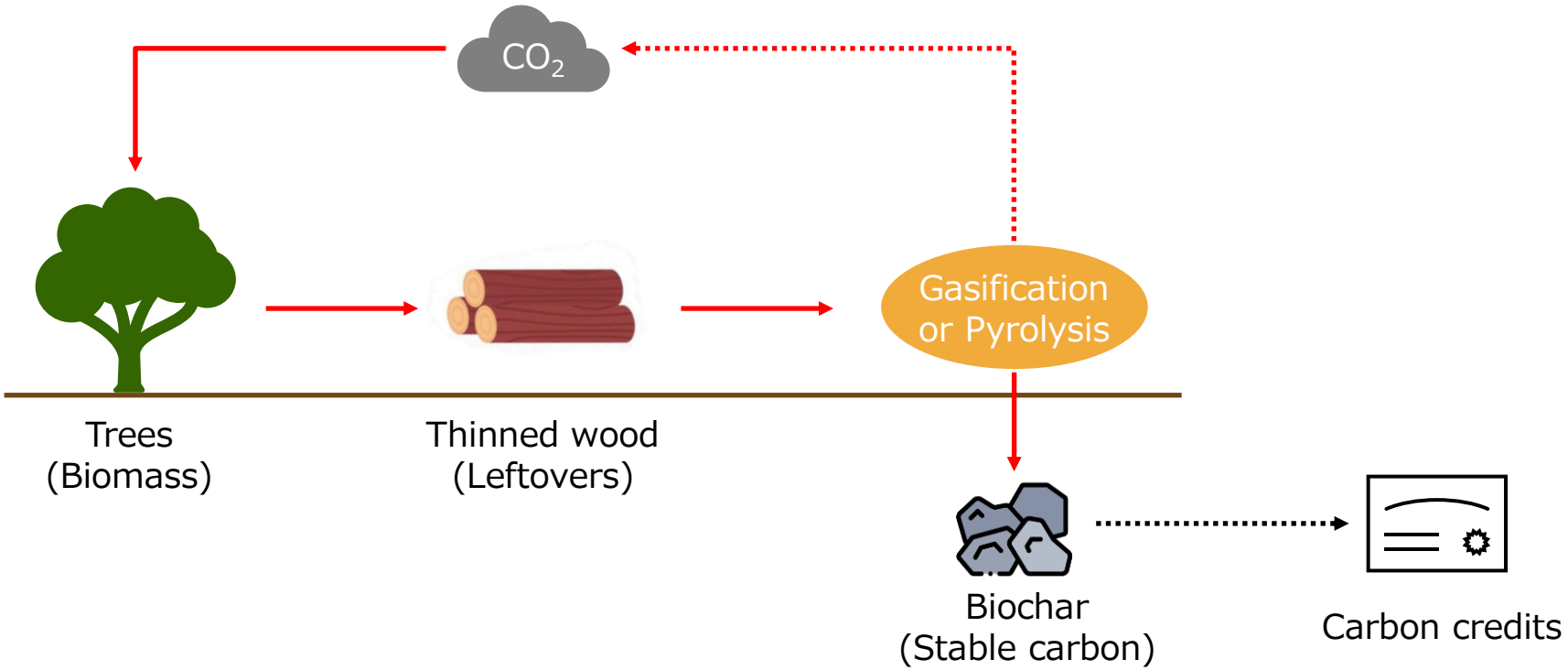


- Trees captures CO2 from the atmosphere (photosynthesis)
- BIOCHAR is carbon resulting from gasification / pyrolysis of trees
- Thus, through use of biochar, gasification biomass power plant can become “carbon negative”
- Carbon credit can be issued for the carbon stored (C-sink)

$CO_2$ neutral energy

+

Negative emission




Biochar image: Flaticon.com

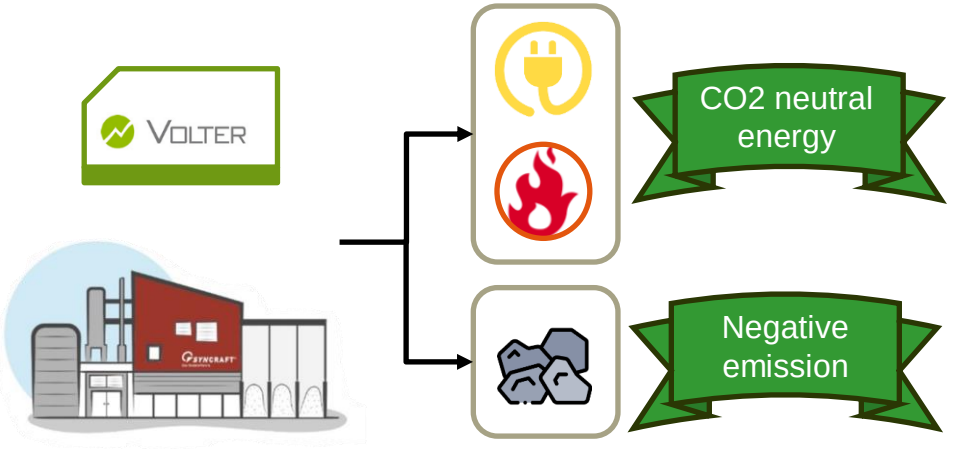
# Forest Energy's Local Biomass Energy Model



- We operate small CHPs (40–2,000kWel), which is well suited for decentralized and on-site energy solution
- Small size enables flexibility in location and installation, enabling use of local biomass to produce local energy

## LOCAL BIOMASS

## LOCAL ENERGY




### Use of thinned wood

- Promote proper forest maintenance
- Increase employment in forestry

### Short distance transportation

- Low emission
- Increase local employment

### Gasification CHP plant

- Compact, distributed energy supply
- High energy efficiency

### Carbon negative energy

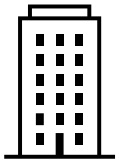
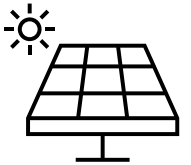
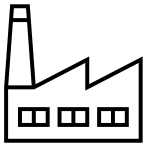
- Baseload electricity
- Negative emission

Biochar image: Flaticon.com

# Installation examples of biomass CHPs



- ZEB / off-grid use is increasing in Japan

| | | | |
|---|---|---|---|
| Power plant |   | Sell electricity (FIT)<br>Heat for drying wet biomass fuel | |
| Zero Energy Building |  | 24/7 electricity<br>Air conditioning Heating / drying | CHP +  |
| Off grid hotel |  | 24/7 electricity<br>Hot water for spa | CHP |
| Agriculture |  | Sell electricity<br>Air conditioning for greenhouse horticulture | CHP |
| ESCO for factory |  | SYNGAS to mix with, and reduce natural gas | SYNGAS |

# Power plant: Shingu Forest Energy



- Power generation: 1,764kW
- Shingu City, Wakayama prefecture, Japan
  - Population: 26,841
  - Land: 25,523 ha
  - Forest rate: 91%
- In operation since 2021
- Biomass: Thinned wood from local forest. 20,000 t/y
- Electricity off-take: Feed-in-tariff
- Heat off-take: used for drying biomass

SYNCRAFT® Climate Positive Solutions.

# Power plant: Shingu Forest Energy



- “the first carbon-negative power plant in the APAC region”

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## Jenbacher engines at the heart of Japanese-led wood power plants

**A wood power plant in Shingu City serves as the first carbon-negative power plant in the APAC region, operating with SynCraft's reverse power plant technology. The combination of Syncraft's climate-positive system and INNIO's innovative Jenbacher engine technology is expected to continuously feed Japan's grid with renewable power for approximately the next 20 years. (Image: Shingu Forest Energy LLC)**

A wood power plant in Shingu City serves as the first carbon-negative power plant in the APAC region, operating with SynCraft's reverse power plant technology. The combination of Syncraft's climate-positive system and INNIO's innovative Jenbacher engine technology is expected to continuously feed Japan's grid with renewable power for approximately the next 20 years.

### Tapping into Tariff Power

Japan committed to achieve carbon neutrality by 2050, reduce greenhouse gas emissions (GHG) by 46% in 2030 from its 2013 levels, and decrease dependency on nuclear power. As part of these efforts both to decarbonize and reduce the country's reliance on nuclear energy, the government of Japan established Feed-In Tariffs (FIT) to provide renewable energy projects in order to accelerate the adoption of renewable energy. Under the FIT initiative, Japanese utilities can buy electricity from renewable sources, such as, biomass, at pre-set premiums. Japan's FIT policy has stimulated the growth of two energy segments: Wood gas and biogas.

To empower the governmental plans, Shingu Forest Energy LLC -- an entity of Forest Energy Corporation -- moved forward with plans to construct the first biomass power generation project to operate in Shingu City, Wakayama Prefecture, Japan. The Japanese-led team turned to INNIO's Jenbacher J412 engines.

The use of biomass for decentralized power and heat generation is an increasingly important aspect of the energy transition and associated decarbonization. In contrast to wind and sun, regrowing raw materials such as wood are constantly available and can be used in the form of wood gas to generate power and heat in SynCraft's reverse power plant using Jenbacher engines. Wood gas has a hydrogen content (energy based) of over 40%. These plants achieve a fuel utilization rate of up to 92%, as well as offer another valuable advantage: in contrast to conventional plants, this new and innovative system produces biochar, rather than ash.

The overall system is capable of releasing only part of the CO2 that originally is stored through the forest. Some of it remains as useful green carbon, thus making SynCraft's system climate-positive.

### Powering carbon-negative plants with wood gas

Commissioned in December 2021, the Jenbacher engines have been tailored to meet the needs of wood gas, marking the world's first 60 Hertz carbon-negative power plant delivering more than 1.7 megawatts of power. This reverse power plant uses the waste heat of four Jenbacher J412 engines as well as the heat emerging from the gasification process for a total of about 3.8 MW thermal for district heating and fuel drying. The combined heat and power configuration allows the Shingu City wood power plant to achieve an overall fuel efficiency of about 85%. Additionally, every operating hour yields around 200 kilograms of valuable biochar, which can be used for barbecues, animal feed supplementation or soil fertilization.

The use of biomass for decentralized power and heat generation is an increasingly important aspect of the energy transition and fully supports Japan's goals to decarbonize its power sector. The wood power plants, operating with Jenbacher engines, provide green and secure power because of the constant availability of wood. Additionally, the Jenbacher technology delivers a balancing power source to the grid to support the frequency stability due to the increasing higher share of intermittent renewables sources like photovoltaic. These plants are optimized with a wood gas fuel application, providing an alternative solution for decentralized power generation that is a renewable 'green energy'. The reverse power plant provides high power generation efficiency, using bark and branches as fuel well as the chipped stemwood.

**The use of biomass for decentralized power and heat generation is an increasingly important aspect of the energy transition and associated decarbonization, according to INNIO. (Image: Shingu Forest Energy LLC)**

The combined heat and power configuration is expected to use about 20,000 tons of unutilized wood resources annually from the Wakayama region. The material is chipped and used as fuel in the reverse power plant with the heat used to dry the woodchips. The heat from the plant makes it possible to keep drying cost low and use freshly cut wood as fuel. Additional uses for the residual heat are under exploration.

INNIO and SynCraft, an Austria-based industry leader in wood power plants, have not only delivered and commissioned this project in Japan but also in six European countries. Not only do these highly innovative power plants align with nature, but they have a real climate-positive effect as well.

https://www.dieselgasturbine.com/news/power-plants-of-the-world/8026775.article

# Power plant: Tsuwano Forest Energy



- Power generation: 480kW
- Tsuwano town, Shimane prefecture, Japan
  - Population: 6,875
  - Land: 30,704ha
  - Forest rate: 90%
- In operation since 2022
- Biomass: Thinned wood from local forest. 6,000 t/y
- Electricity off-take: Feed-in-tariff
- Heat off-take: used for drying biomass


# ZEB (net-zero energy building) and CHP



- Takasago Research Center is powered by solar and biomass CHP
- Heat from CHP is used for both COOLING and HEATING
  = Desiccant air conditioning
- Surplus electricity is stored in 3MW battery


# Agriculture and CHP



- Forest Energy's demonstration site
- Heat is used to 1) heat greenhouse, 2) heat mushroom bed cultivation and 3) dry fruits
- Electricity is sold to the grid (FIT)



# Business model: CHP x Biochar

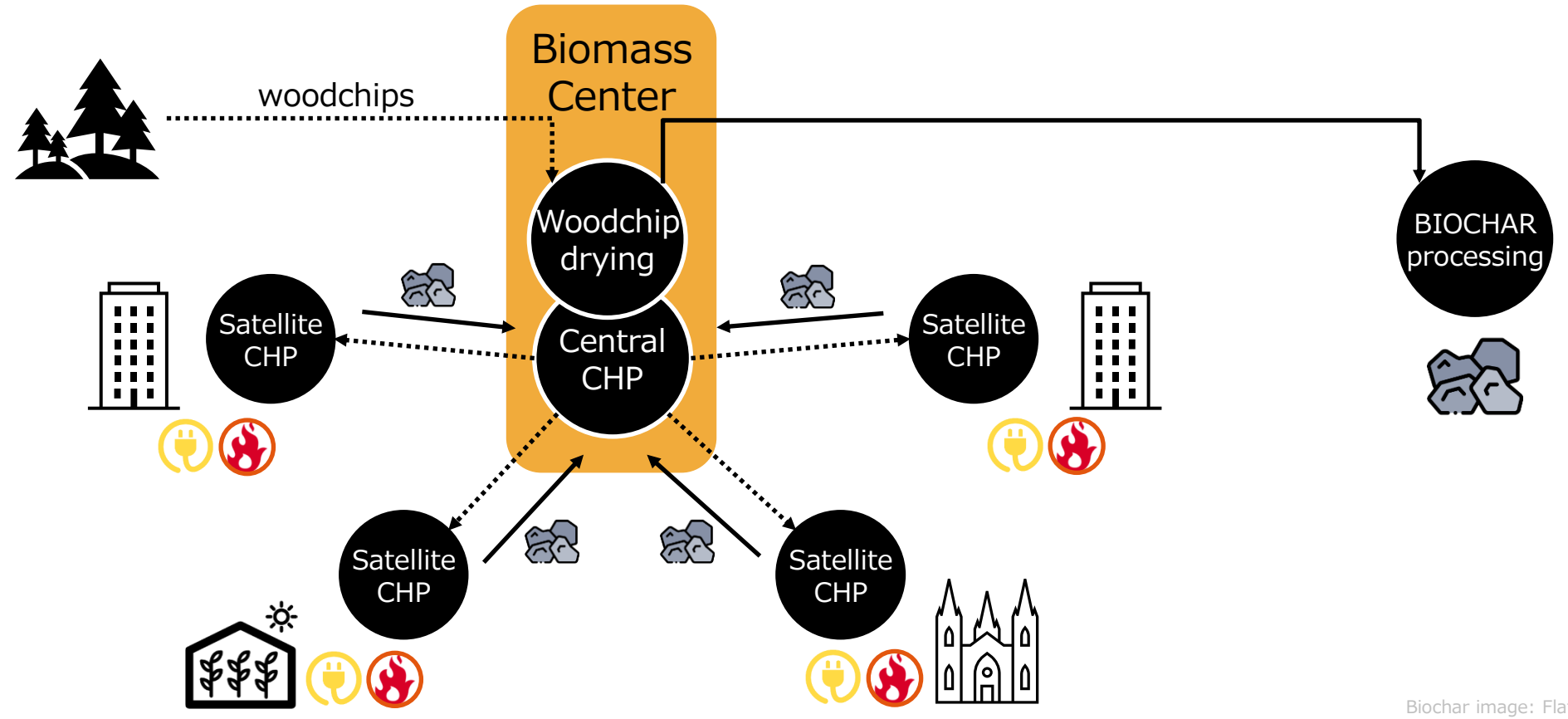


- Decentralized / On-site “carbon negative” energy production site
- Centralize fuel preparation, logistics, maintenance, and biochar processing to reduce investment and operation cost
- Produce BIOCHAR as byproduct of energy, to reduce cost of CCS

Decentralized and On-site $CO_2$ neutral energy

+

Negative emission




Biochar image: Flaticon.com

# Application of biochar for carbon storage



- We are still at development stage of applying biochar in real life
- Carbon farming: Biochar can increase soil fertility, water holding capacity and crop productivity, Thus, it can be used to reduce usage of fertilizer and improve crop yields
- Green construction material: Biochar can be mixed in asphalt and concrete. Carbon credit can be issued in certain voluntary market
- It is critical to test and find local solution for biochar.

## CARBON FARMING

### SOIL IMPROVEMENT


### ORGANIC FARMING

## PRODUCT STORAGE

### ASPHALT

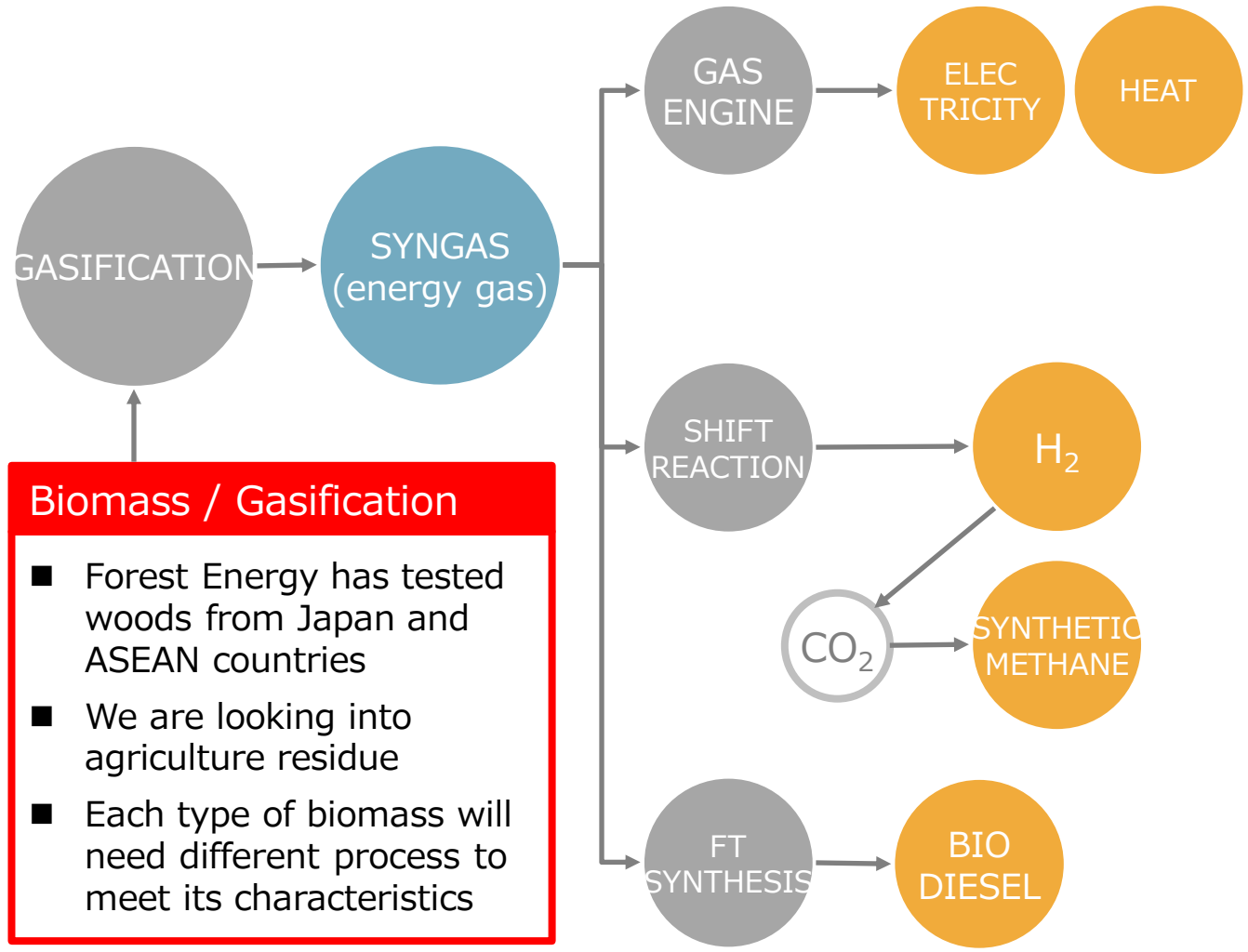

### CONCRETE


Picture courtesy of Forest Energy's partners

# What we are doing today at Forest Energy



- Preparing small gasification unit to match ASEAN + India conditions
- Preparing demo-plant for GREEN HYDROGEN production




## Biomass / Gasification

- Forest Energy has tested woods from Japan and ASEAN countries
- We are looking into agriculture residue
- Each type of biomass will need different process to meet its characteristics

## Commercialized

- CHP, Combined Heat & Power
- Baseload electricity source
- Distributed power supply, used in many EU countries. Japan underway
- Power generation efficiency 20-30%
  Total energy efficiency 80-90%

## Demonstration in progress

- Gas to Gas
- Onsite H2 production

- Green LNG
- Green LPG

## Laboratory test

- Biomass to Liquid (BTL)
- Bio jet fuel

# Next step for CEFIA: Webinar



The IPCC (Sixth Assessment Report, 2022) estimated that the annual emission reduction potential of biochar would reach 1.1 billion tons ($CO_2$ equivalent), enough to offset Japan's annual GHG emissions. Biochar presents an appealing and accessible solution, but its successful implementation necessitates a profound understanding of local contexts.

In the coming months, we would like to organize a webinar, for people interested in creating decentralized network of “carbon negative” power plants using biochar.

- WEBINAR
  Business model for biochar: Production, application of biochar and issuance of carbon credits
- PURPOSE
  Build network among business and academic people interested in biochar.
- TARGET AUDIENCE
  Businesses, universities and government officials interested in biochar and use of gasification CHP or pyrolysis.
- BACKGROUND
  It is very important to think local and involve locals to create biochar application, which is critical to develop decentralized network of “carbon negative” biomass power plants using biochar. This approach not only maximizes the utilization of locally available biomass resources but also empowers communities to actively participate in sustainable energy production and carbon sequestration initiatives. By engaging local expertise and fostering community ownership, the journey towards establishing these biochar-integrated power plants becomes a collaborative effort that not only addresses environmental concerns but also promotes economic growth and resilience at a grassroots level.