



Force Energy Systems Inc. represents manufacturers of Waste Heat to Power (WHP) and Combined Heat and Power (CHP) equipment.

Clean Energy efficiently generated from alternative and renewable sources is Force Energy's primary focus.

**BIOMASS CHP – TEOPOWER**



## CA Forest Biomass Working Group – February 20, 2019

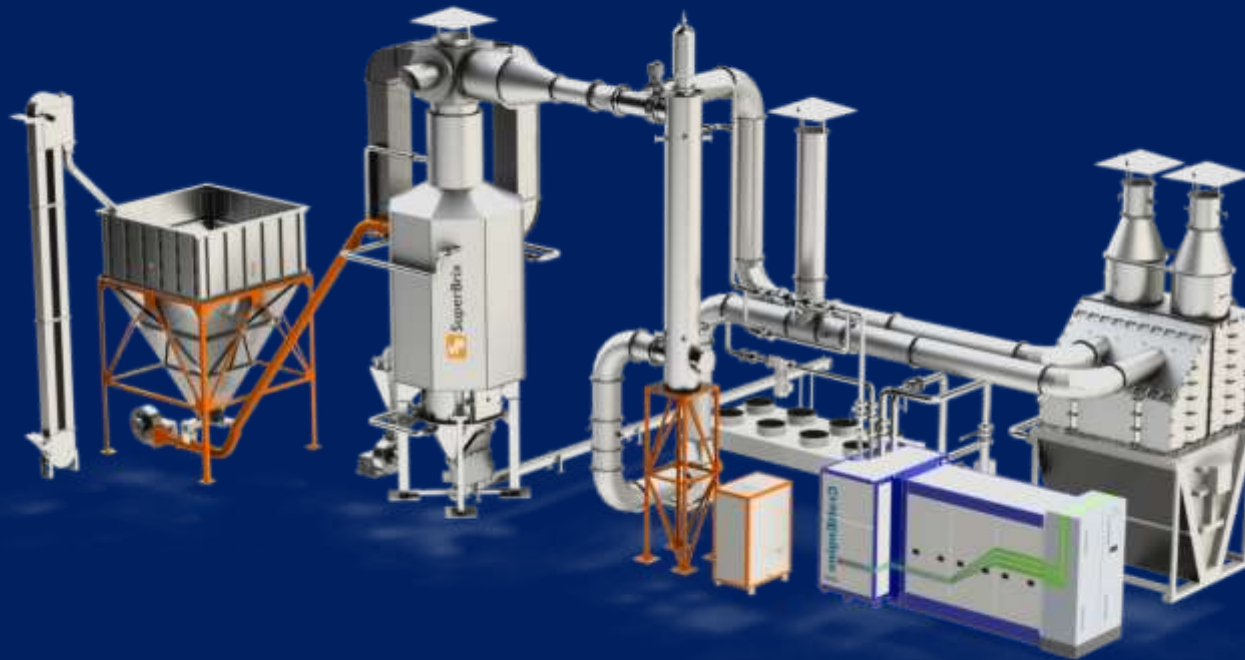
- Restoration & Resilience of California's Forests
- Energy from Forest Residues
- Increase the Utilization of Forest Biomass
- Minimize Transportation Costs & Use of Fossil Fuels
- Maximize the Benefits to Communities





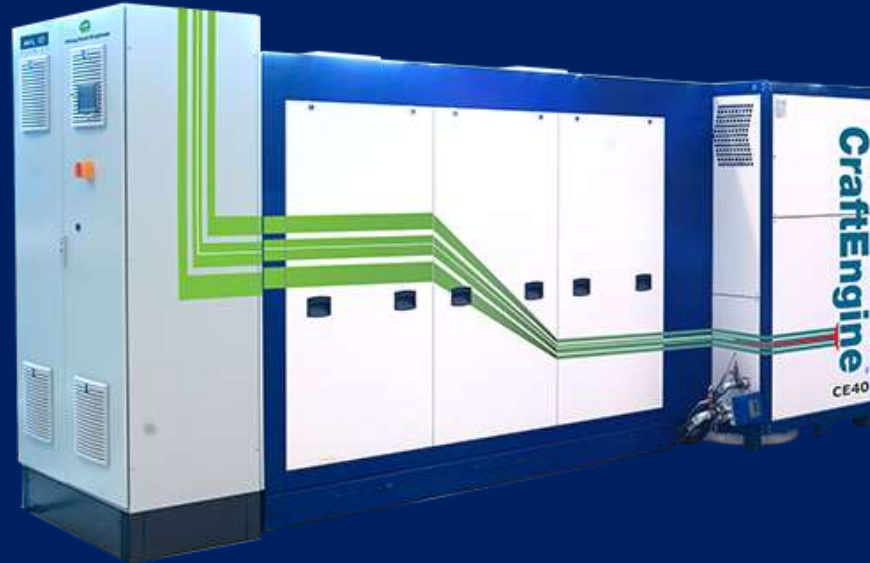
# TEOPOWER

## Biomass to Energy Solution



20160408/HNR-V1.0

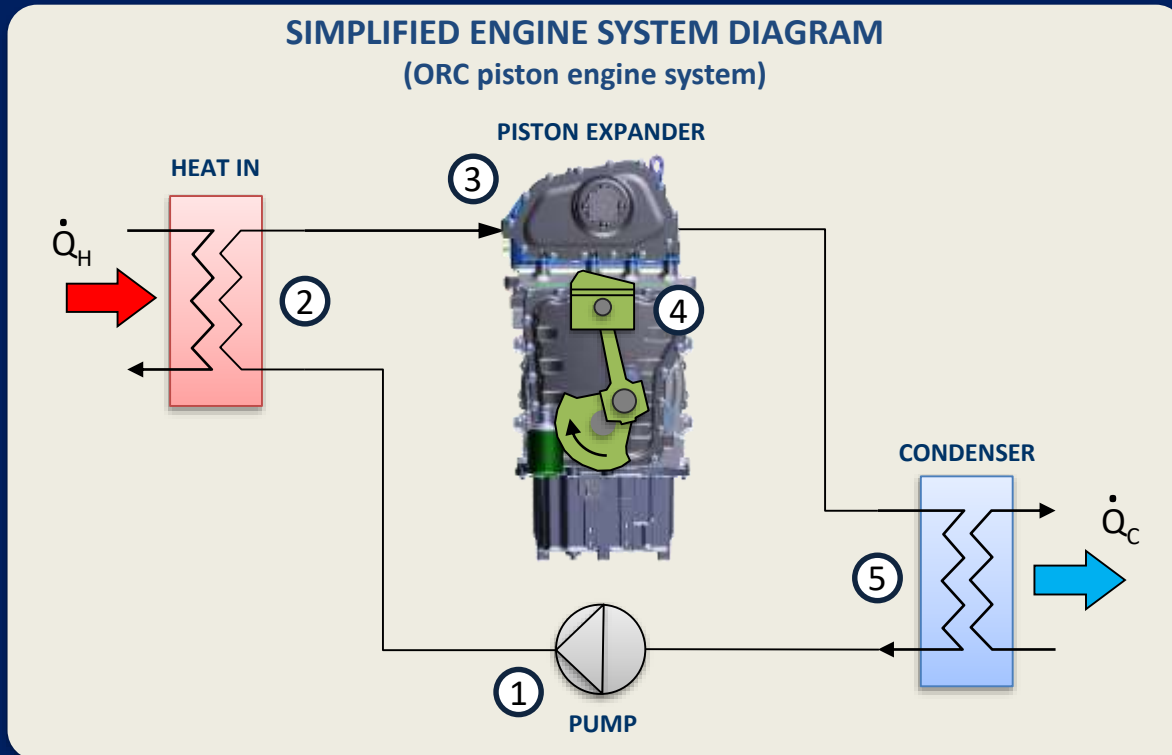
# Viking Heat Engines The CraftEngine



# THE WORKING PROCESS OF THE CRAFTENGINE™ IS THE ORGANIC RANKINE CYCLE (ORC)

THE WORKING FLUID GOES THROUGH THE FOLLOWING STEPS:

1. Pumped from low to high pressure
2. Heated and boiled at high pressure (phase change from liquid to vapor)
3. Injected into the engine
4. Expanded in the engine working cylinder (from high to low pressure)
5. Exhausted and condensed at low pressure (phase change from vapor to liquid)



# The CraftEngine

## Typical Applications



*Using excess heat from Boilers*



*Using Generator Waste Heat  
(Exhaust Gas & Jacket Water)*



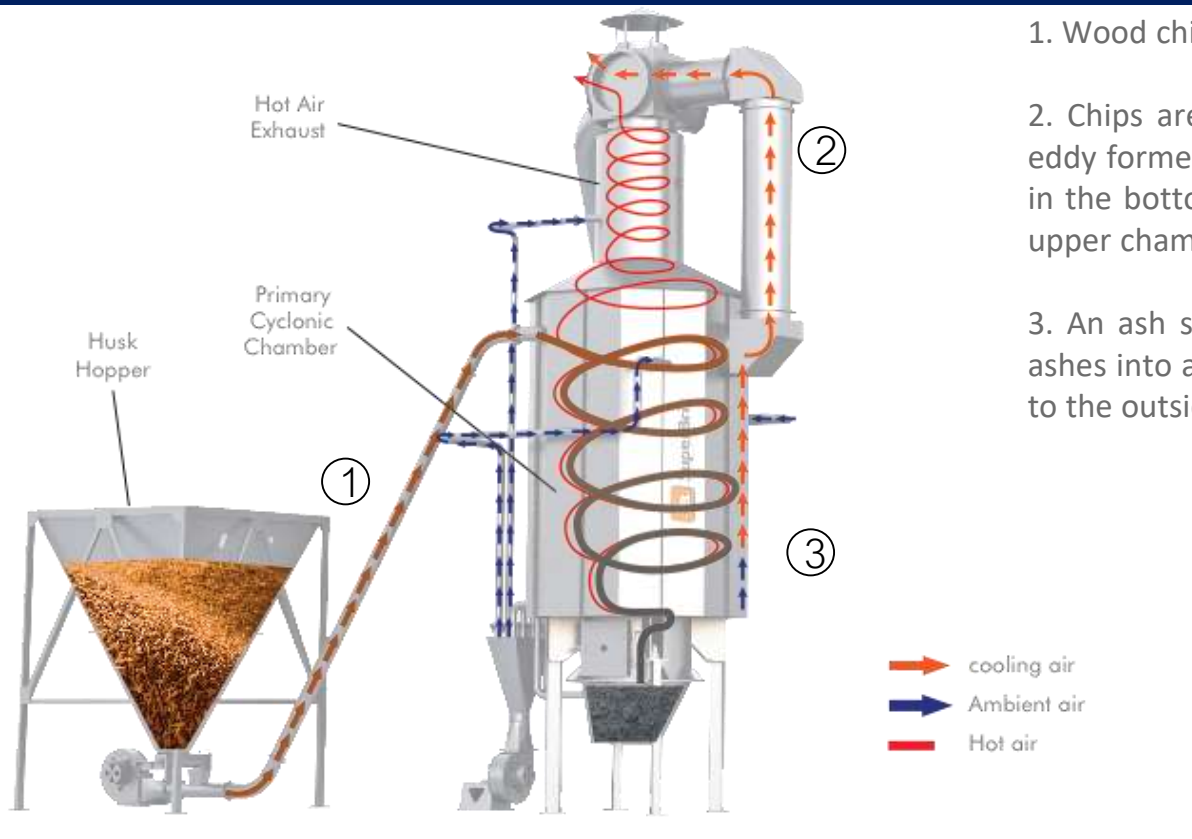
# CHP Installation in Germany

- CraftEngines integrated with a Gasifier/CHP unit using jacket water and exhaust gas
- Flexible operation with varied heat inputs while maintaining a high efficiency
- Designed for long life – first overhaull at 40,000 + hours



# SuperBrix TEO IV Cyclone Furnace

## Controlled Combustion and Material Handling



1. Wood chips enter the air-driven combustion chamber

2. Chips are burnt generating a complete combustion in an eddy formed in the inside of the furnace that suspends ashes in the bottom of the chamber and pushes the hot air to the upper chamber

3. An ash sweeper that slowly rotates inside discharges the ashes into a hopper, where ashes are cooled and transported to the outside through a conveyor.



### TEO furnace

- Feed system
- Ash discharge to scope boundary limit
- Combustion and exhaust blowers
- Waste gas ducting to battery limits
- Insulation
- Control system

### CraftEngine

- Piping to battery limits
- Electrical connection to internal grid
- Control system

### Heat Transfer

- Flue gas to water heat exchanger
- Ducting to scope boundary limit
- Piping to scope boundary limit
- Circulation pump
- Control & Safety system
- Insulation

### Cooling

- Air cooled condenser
- Piping to scope boundary limit
- Circulation pump

### Miscellaneous

- Engineering of TeoPower scope
- Shipping to destination port
- Installation Supervision
- Commissioning

## Model Summary Sheet (Maximized Electricity)

| Case*                                | TeoPower<br>40                        | TeoPower<br>80                       | TeoPower<br>120                       | TeoPower<br>160                       | TeoPower<br>240                         |
|--------------------------------------|---------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|---|
| Fuel Required**                      | 190 kg/h<br>0.21 t/h                  | 370 kg/h<br>0.41 t/h                 | 560 kg/h<br>0.62 t/h                  | 745 kg/h<br>0.82 t/h                  | 1,110 kg/h<br>1.2 t/h                   |
| Electricity (net)                    | 33 kW <sub>e</sub>                    | 70 kW <sub>e</sub>                   | 105 kW <sub>e</sub>                   | 140 kW <sub>e</sub>                   | 205 kW <sub>e</sub>                     |
| Heat in Exhaust Gas<br>@200°C/392°F  | 200 kW <sub>th</sub><br>.682 MM BTU/h | 410 kW <sub>th</sub><br>1.4 MM BTU/h | 610 kW <sub>th</sub><br>2.08 MM BTU/h | 815 kW <sub>th</sub><br>2.78 MM BTU/h | 1,220 kW <sub>th</sub><br>4.16 MM BTU/h |
| Heat in Cooling Water<br>@50°C/122°F | 450 kW <sub>th</sub>                  | 905 kW <sub>th</sub>                 | 1,350 kW <sub>th</sub>                | 1,800 kW <sub>th</sub>                | 2,690 kW <sub>th</sub>                  |

### Notes:

\* All cases calculated using 18°C ambient temperature

\*\* Wood-chip fuel used is (heat content assumed is 18,000 kJ/kg (7738 BTU/lb))

PLEASE NOTE THAT ALL OF THE ABOVE FIGURES ARE BASED ON STANDARD TEOPOWER MODELS WHICH MAXIMIZE ELECTRICAL OUTPUT. IF **HEAT DELIVERY** IS THE PRIORITY A LARGER FURNACE MODEL CAN BE UTILISED TO MEET CUSTOMER REQUIREMENTS.

# Typical delivery and set-up of a containerized system

## Key features:

- CE40 pre-installed in container
- Air cooled condenser designed and specified to be installed on top of container.
- Easy delivery, installation, and commissioning
- Container doors on 3 sides for ease of maintenance



# Packaged Systems for Biomass – Remote/Rural/Industrial/MSW



## Forest Residue Processing with TeoPower:

- Briquettes produced with heat and power – densified product shipped to market.



# Processing Continued: Posts, Rough Cut Lumber,...





## On-Grid – Decentralized Energy

- BioMAT
- Self Generation Incentive Plan - CHP
- Feed In Tariff
- Net Metering
- Energy Offset – Sustainable & Resilient



**Thank you for your time and please ask your questions.**

**[www.force-energy.com](http://www.force-energy.com)**