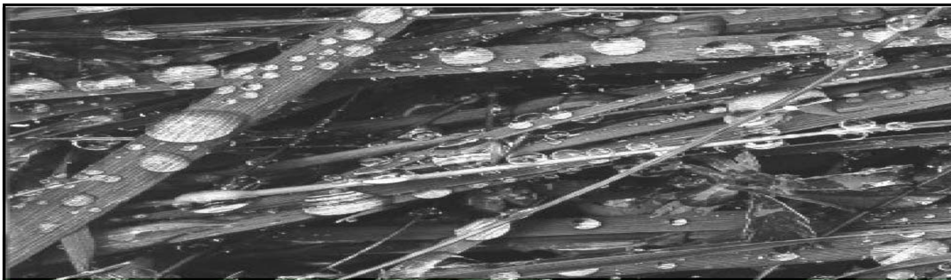


# Overview on Biomass based Co-generation and Syngas/Hydrogen Production

A presentation prepared by Dr.-Ing. H.-P. Grimm, WIP Munich



## Energy - the basis of all life

- 2000 years ago - Roman empire
  - specific energy consumption approx. 7.2 GJ per capita/year
- 19th century - 1st industrial revolution
  - specific energy consumption approx. 24 GJ per capita/year
- 20th century - 2nd industrial revolution
  - specific energy consumption approx. 115 GJ per capita/year

## What is the composition of biomass?

- **Most biomasses**
  - consist of hemicellulose, cellulose and lignin plus water and minerals (ash)
  - have an approximate composition of

    45 to 50% carbon

    40 to 45% oxygen

    5 to 6% hydrogen

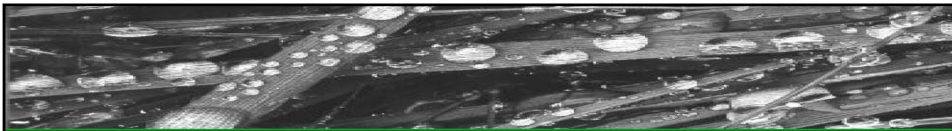
    small amounts of sulphur and nitrogen



## Biomass as a Renewable Energy Source

**is** chemically converted and

**stored solar energy**



## Comparable Energy Values

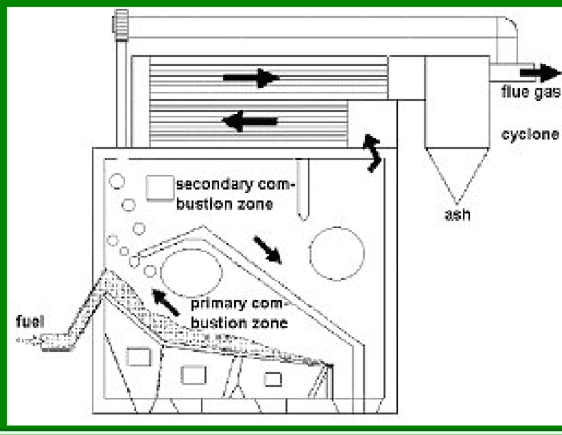
- **Typical calorific values for selected fuels are**
  - **Biomass 17 - 21 MJ/kg**
  - **Peat 20 - 25 MJ/kg**
  - **Coal 30 MJ/kg**
  - **Fuel Oil 40 MJ/kg**
  - **Natural gas 40 MJ/m$^3$**



## Biomass as a fuel can be used

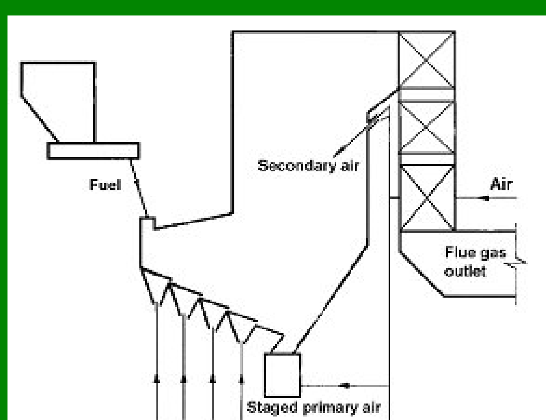
- **for energy production in systems like**
  - **small units as ovens, boilers, etc.**
  - **central heating plants**
  - **thermal power plants**
  - **co-generation units**

# Boilers for Co-generation - Stoker system

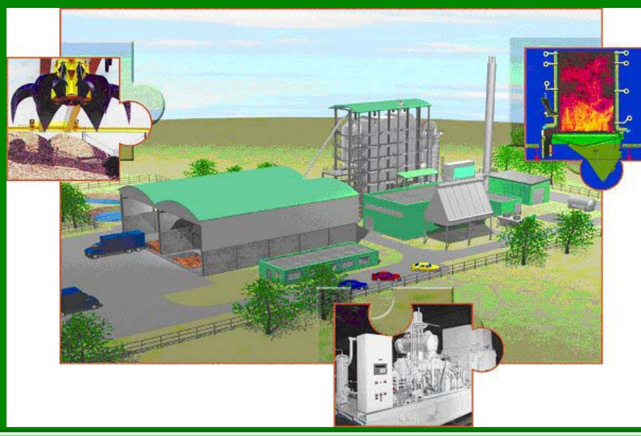





# Boilers for Co-generation – Moving Grate

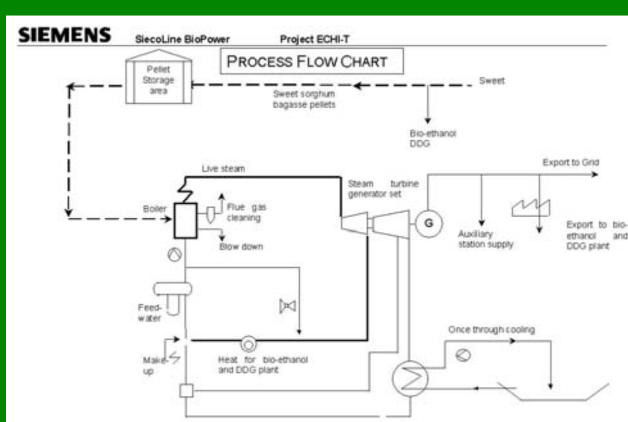


# Solid Biomass for Co-generation





# Schematic Plant Layout for Co-generation



## Biomass as a liquid fuel can be used

- for CHP based on engines and/or turbines
  - by fuelling native vegetable oil or MTBE
  - by fuelling bio-alcohol derived from saccharification/fermentation and distillation
  - by fuelling bio-crude oil derived from pyrolysis and/or other processes



## Biomass Gasification

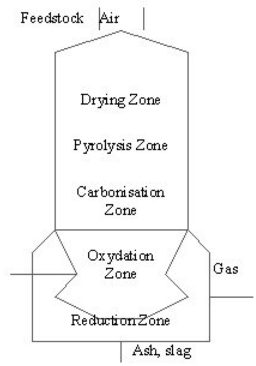
**Different technologies are available:**

- Downdraft – co-current
- Updraft – counter-current
- Circulating
- Combinations of such systems

➢ Main Problem with all systems: Gas cleaning is essential and problematic

## Example for a Downdraft Gasifier

- The gaseous products of the drying zone, pyrolysis zone and carbo-nisation zone pass the hot oxy-dation zone prior of leafing the reactor.
- Most of tars and organic substances are cracked or oxydised. Long-chain hydrocarbons are cracked.
- The process normally requires low moisture fuels, mainly equally shaped.
- The sensible heat content of the producer gas is high. This energy can be regained by passing the producer gases through a heat ex-changer for preheating the oxydising medium and/or partially the fuel.
- Gasifier efficiency reaches 50 - 80%.

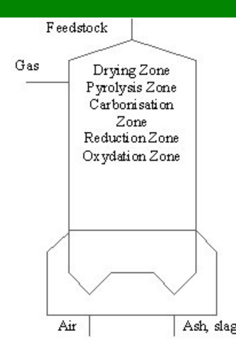



Co-current (downdraft) gasifier



## Example for an Updraft Gasifier

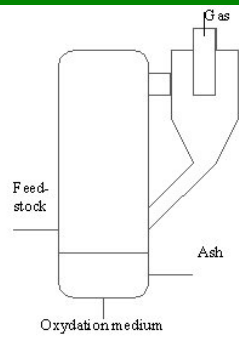
- The requirements in regard to the biomass fuel (moisture, particle size, particle size distribution) are little.
- Decomposition products of the different reaction zones pass through the reactor without further reaction
- The producer gas contains high quantities of moisture, tars and other organic material.
- Due to high reaction temperature some risk of $NO_x$ formation.
- Sensible heat contained in the producer gas is negligible, as the producer gas is cooled down in the course of predrying fuel material.
- Gasifier efficiency reaches 85%




Countercurrent (updraft) gasifier

## Example for a Circulating Bed Gasifier

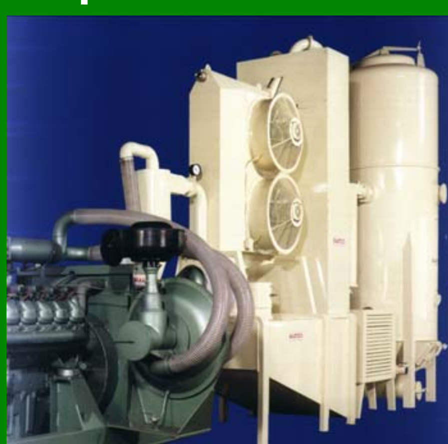
- High flexibility in regard to different kinds of feedstocks.
- Gasification of fine and/or coarse fuels with fuel particle sizes from 1 - 15 mm.
- Generation of producer gases with negligible content of tars and condensibles, but some content of fine particulates.
- Good respond to load variation.
- Low moisture content up to 20% by weight is advantageous.
- Due to high costs of installation and operation only economic with higher capacities of some MW.
- Gasifier Efficiency reaches 50 - 80%



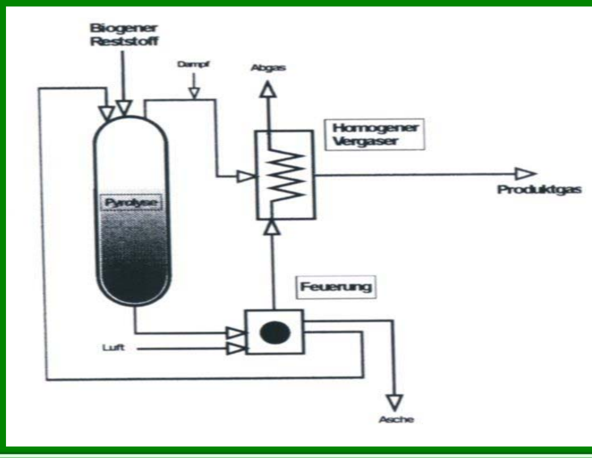

Scheme of a circulating fluidised bed gasifier



## Gasifier coupled to a Gas Engine



## Staged Reforming for a Syngas Production

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## Example for a Syngas Reformer

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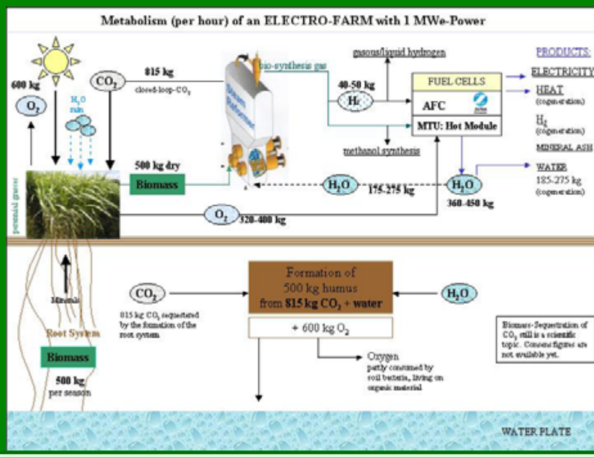
# Example for the Metabolism of Syngas






# Biomass as a gaseous fuel can be used

- by producer gas fuelled to combustion units in order to improve efficiency and to reduce emissions level
- by producer gas fuelled to engines and/or turbines
- by Syngas production/hydrogen reformation/ fuel cell systems

## What are the Credentials of Biomass Utilisation

- Biomass is an energy from the local region
- Biomass is storable - so biomass is an important element of a future solar energy supply e.g. power peak in winter
- Biomass is an environmentally sound and renewable energy source



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