International Workshop on Bioenergy Policies, Technologies and Financing

Utilisation of Biomass – European Technologies and Expectations

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WIP

Energy - the basis of all life

- 2000 years ago - Roman empire
  - specific energy consumption approximately 7.2 GJ
- 18th/19th century - 1st industrial revolution
  - specific energy consumption approximately 24 GJ
- 20th century - 2nd industrial revolution
  - specific energy consumption approximately 115 GJ

Biomass as a *R*enewable *E*nergy *S*ource

Biomass is chemically converted and

stored solar energy

Biomass as a *R*enewable *E*nergy *S*ource

What is the composition of biomass?

Most biomass

- **consist of hemicellulose, cellulose and lignin plus water and minerals (ash)**
- **has 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 *R*enewable *E*nergy *S*ource

What are the characteristics of biomass and fossil fuels for energy production?

Fuel	Moisture content (%)	Lower heating value (kWh/kg dry matter)	Ash content (% of dry matter)
Wood without bark	50 – 60	5.1 – 5.6	0.4 – 0.5
Bark	45 – 65	5.1 – 6.4	2.0 – 3.0
Forest residues (coniferous with needles)	50 – 60	5.1 – 5.6	1.0 – 3.0
Straw	10 – 25	4.0 – 4.2	3.0 – 5.0
Bagasse (South Africa, untreated)	aver. 69.5	aver. 1.8	aver. 1.7
Bagasse (ash incl. contaminants) treated	0 / 20	5.0 /3.9	1.0 – 3.0
Pellets	< 10	> 4.7	< 0.7
Coal	6 – 10	7.2 – 7.9	8.5 – 10.9

Biomass as a *R*enewable *E*nergy *S*ource

- There are some alternatives for the production of biomass for energy
  - intensive production on highly productive agricultural land
  - extensive production on marginal land
  - biomass residues from forestry and set-aside land

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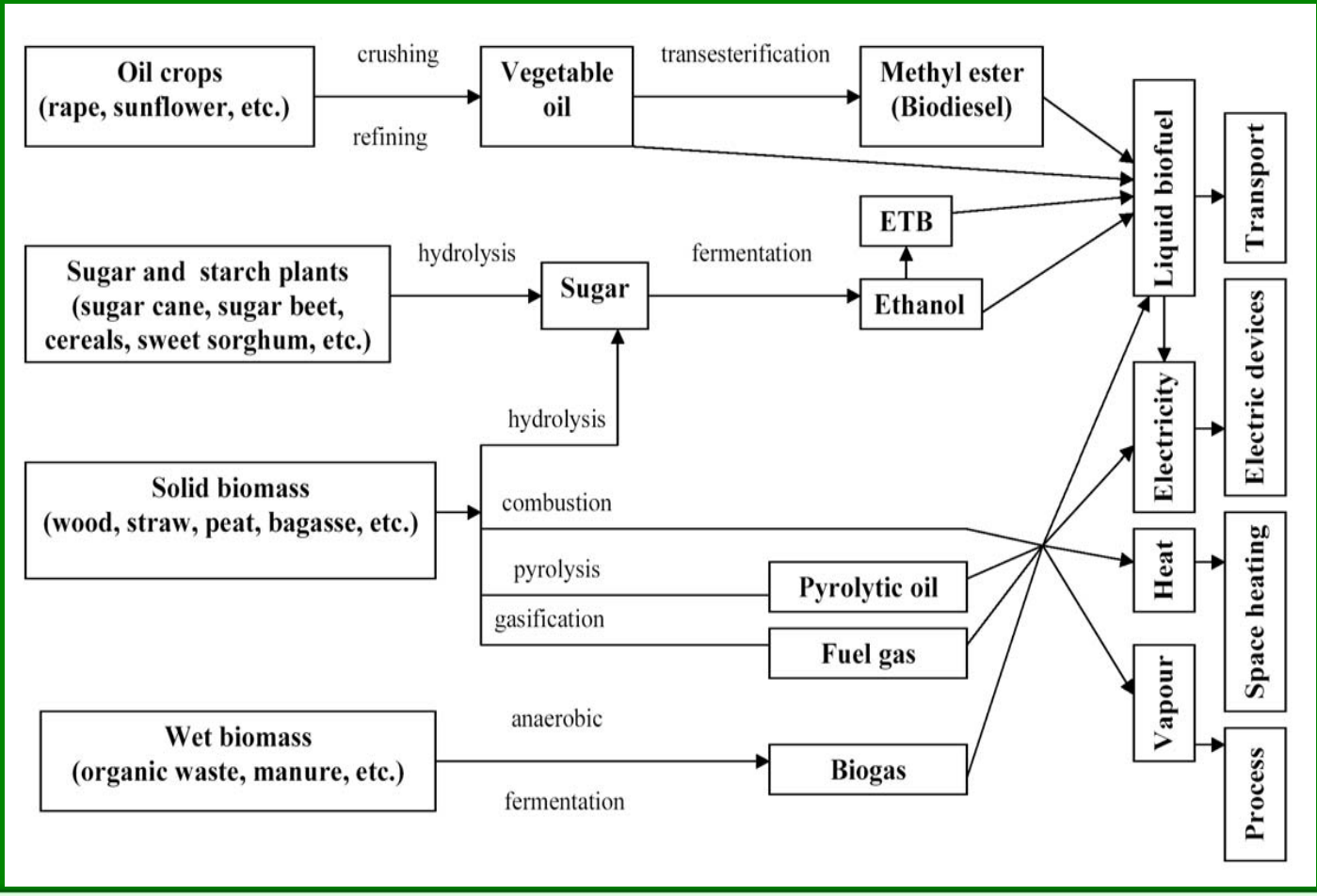
Biomass as a *R*enewable *E*nergy *S*ource

- **Benefits**
  - **Job creation - 6 to 15 jobs per 1,000 TOE bioenergy**
    - **in industry**
    - **in agricultur and forestry**
- **Constraints**
  - **competition in land utilisation**
  - **ecological risks**

Biomass as a *R*enewable *E*nergy *S*ource

Main bioenergy transformation routes



Biomass as a *R*enewable *E*nergy *S*ource

- **Solid biofuels are used by around 90% for the production of heat.**
- **They can be transformed to energy and/or energy carriers by:**
  - **Combustion**
  - **Thermal treatment**
  - **Thermal degradation**

Examples of biomass fuels

- C

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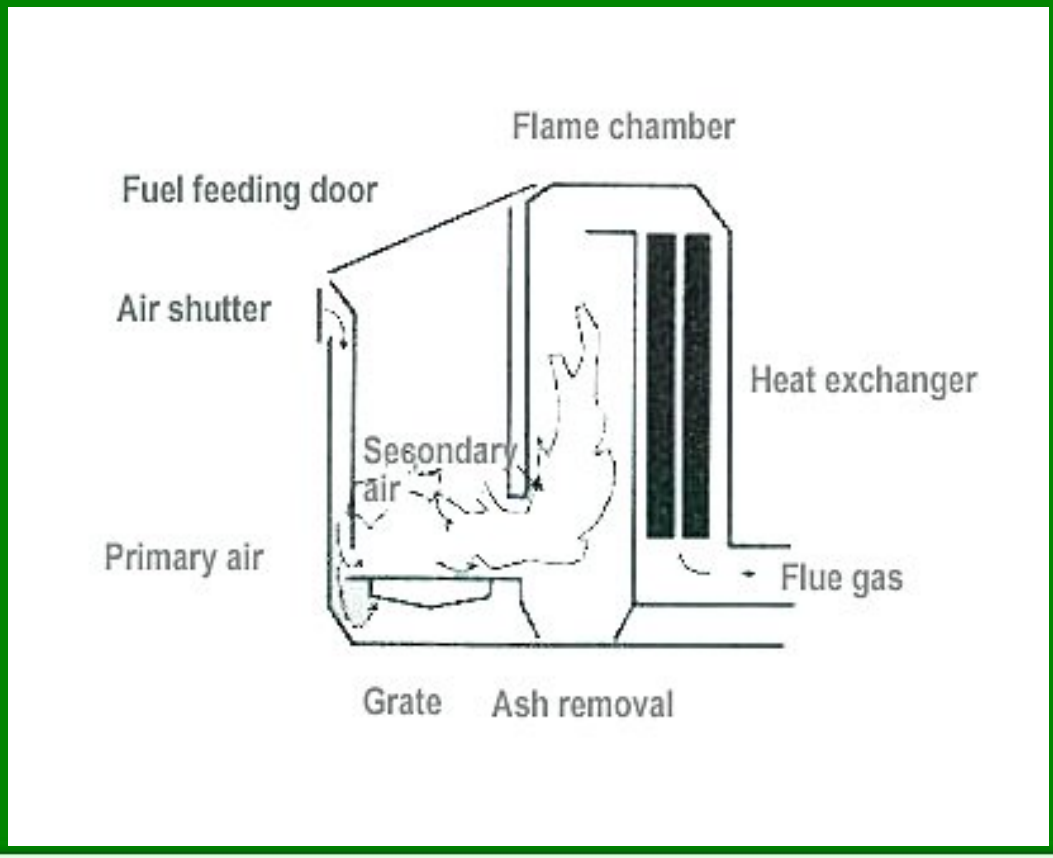
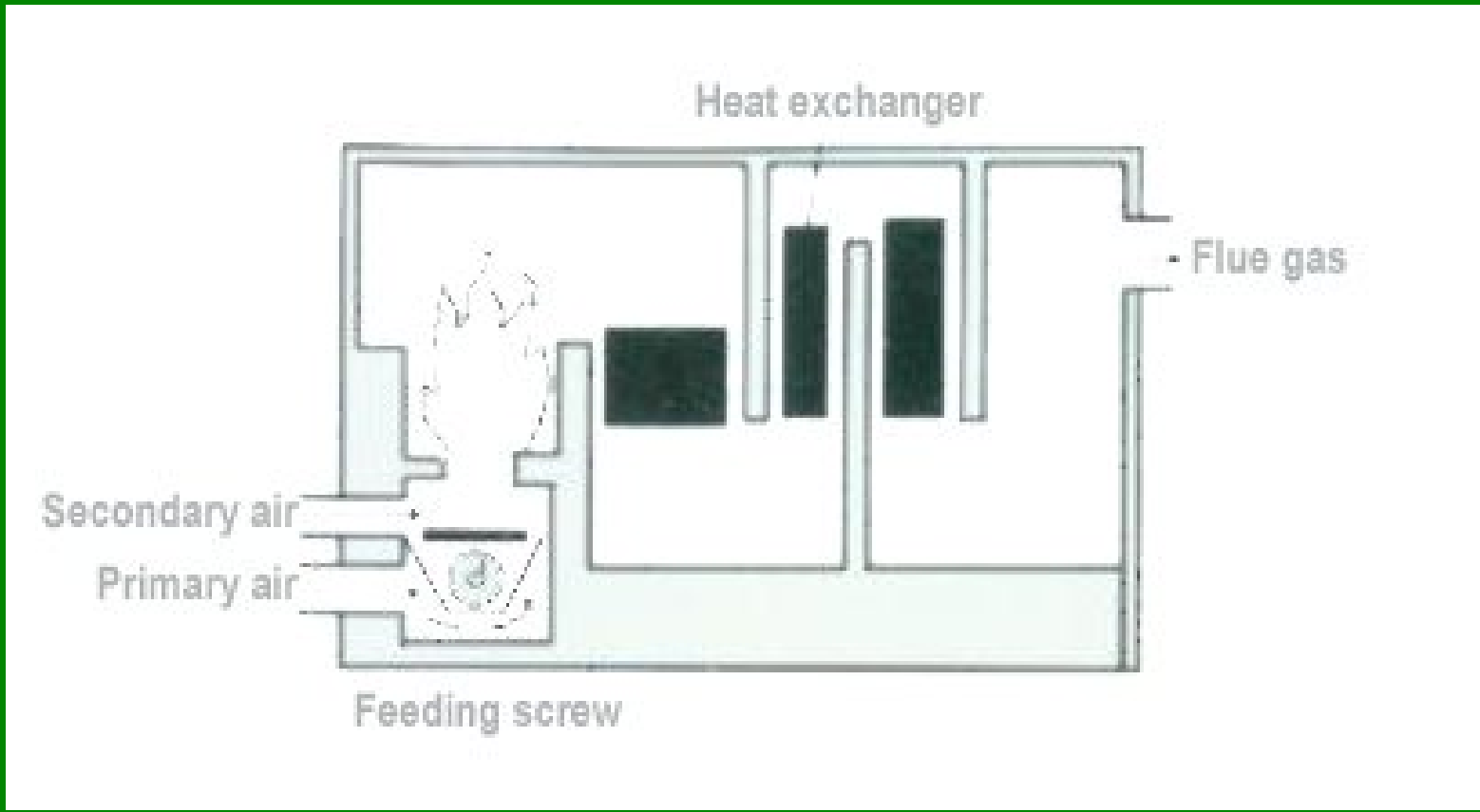
Schematic design for standard conversion systems

- **Simple shaft furnace used for chips, logs, pellets, etc. mainly for domestic heating**



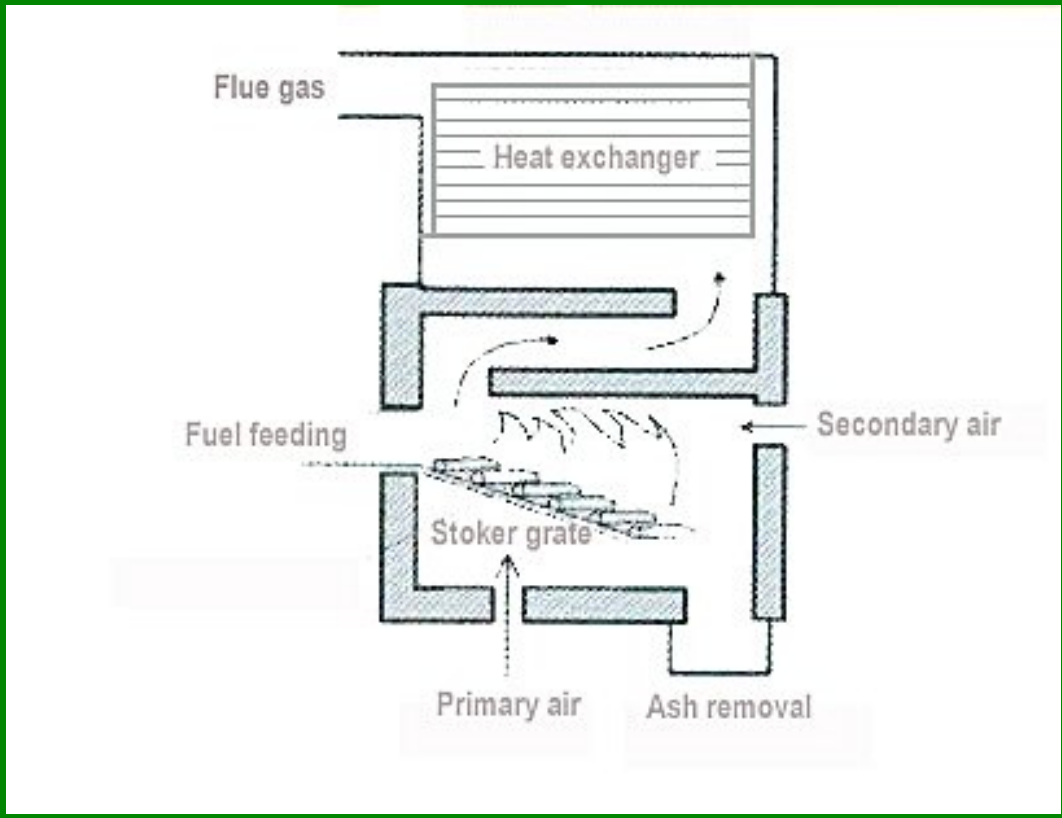
Schematic design for standard conversion systems

- **Underfeed furnace as is used for bigger heat demand**



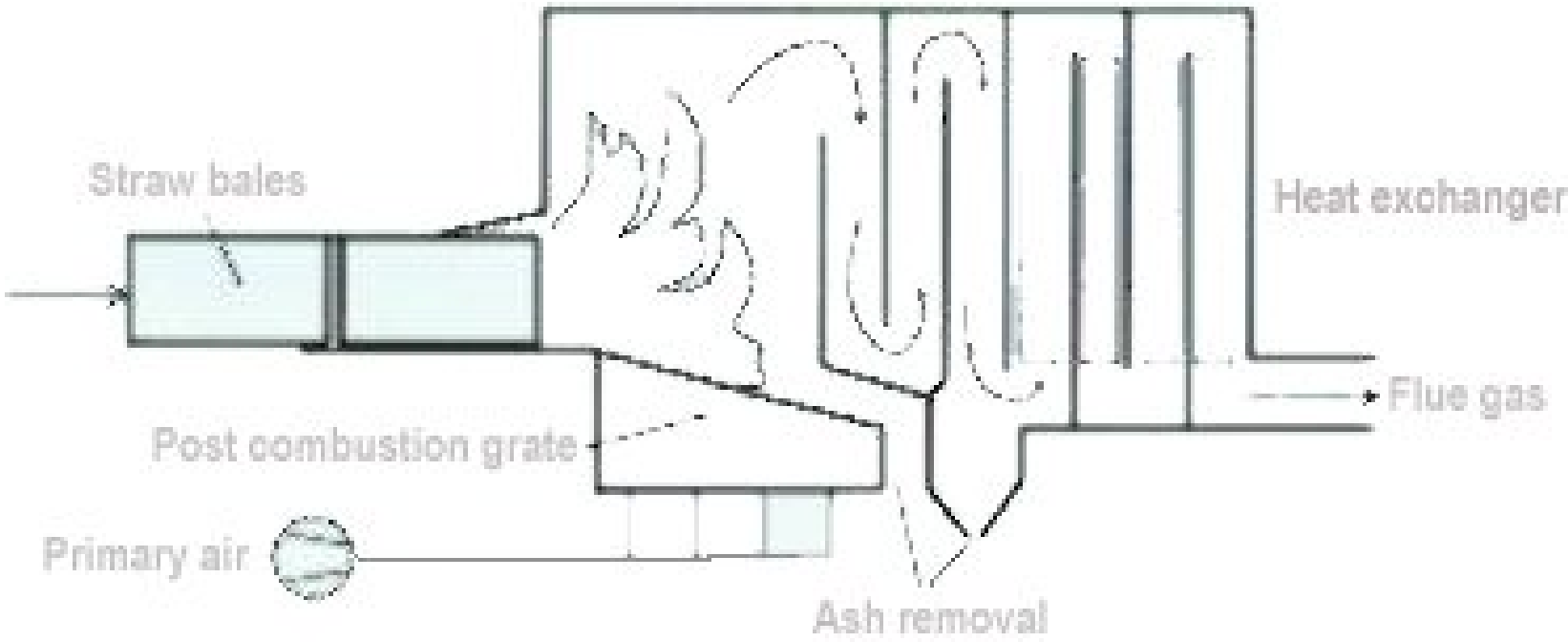
Schematic design for standard conversion systems

- **Grate furnace as is used for bigger heat demand and also for incineraton**



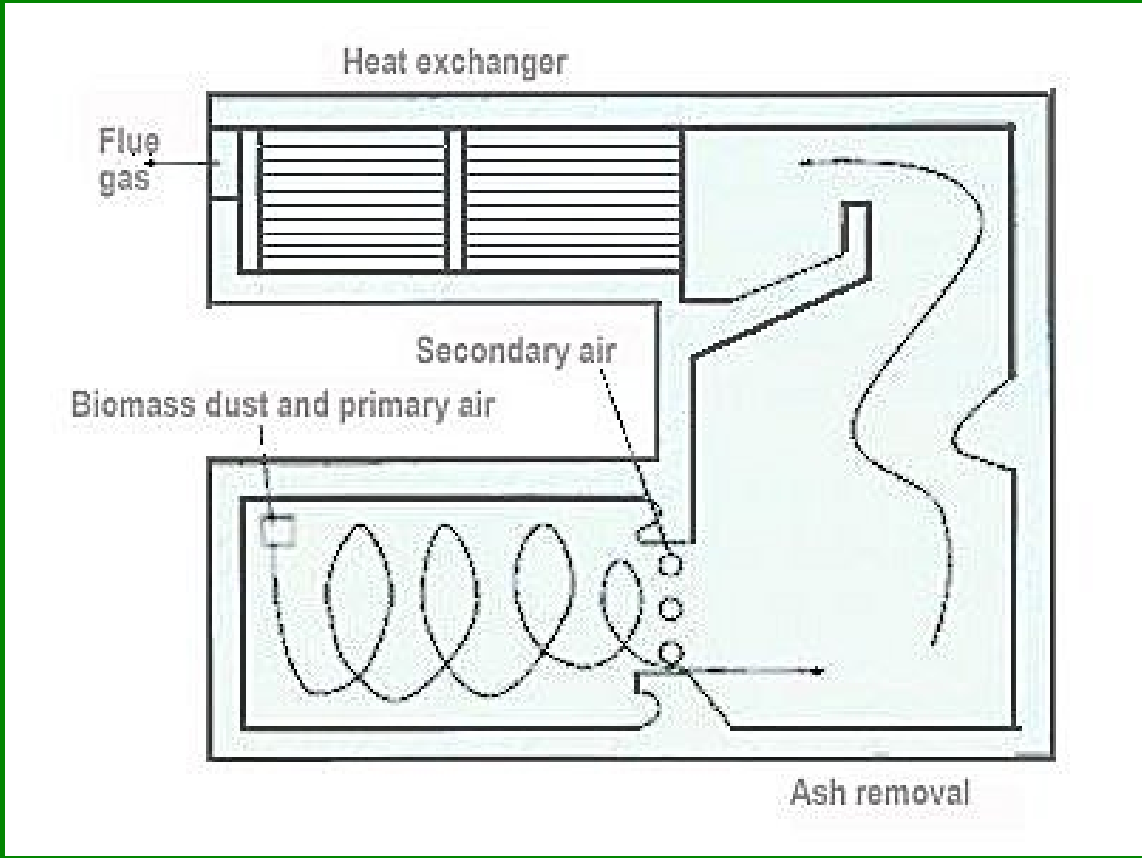
Schematic design for standard conversion systems

- **Specified furnace for straw combustion**



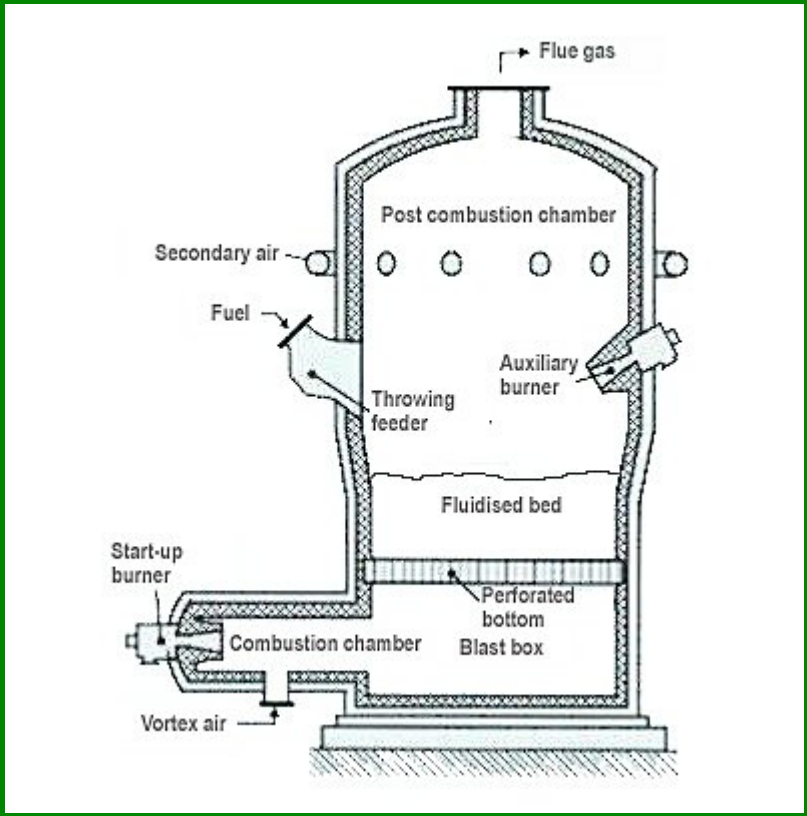
Schematic design for standard conversion systems

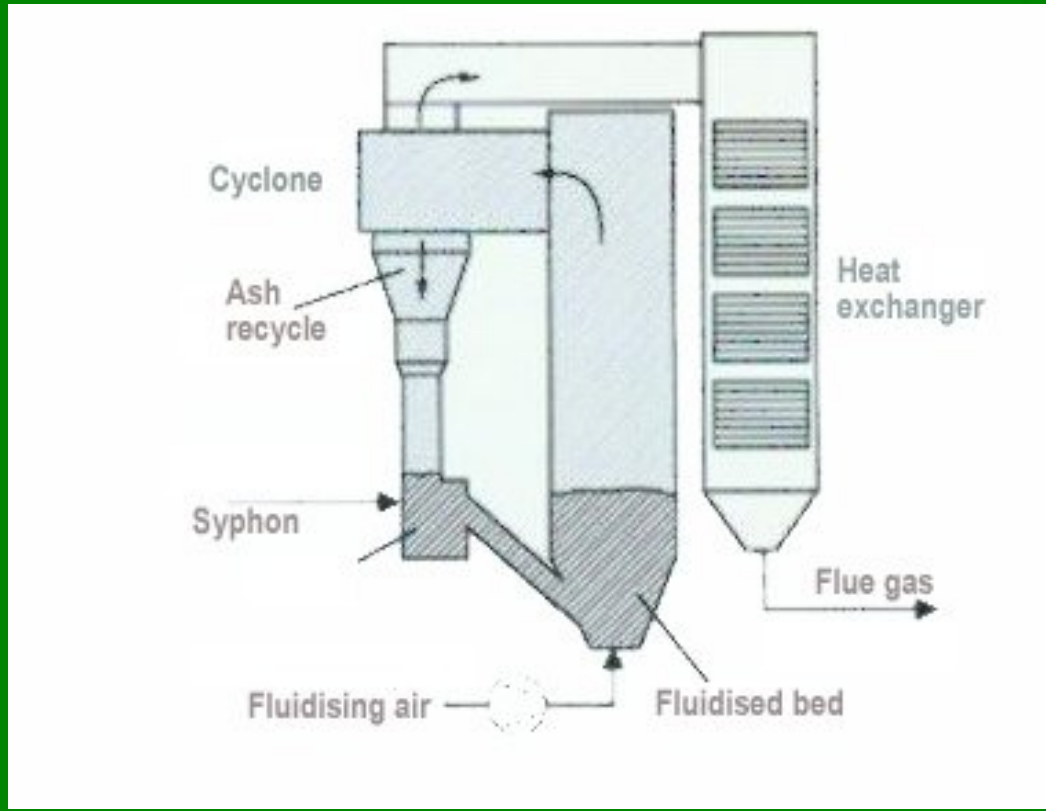
- **Dust injection muffel furnace**



Schematic design for standard conversion systems

- **Fluidised bed combustors**





Conventional power generation technology

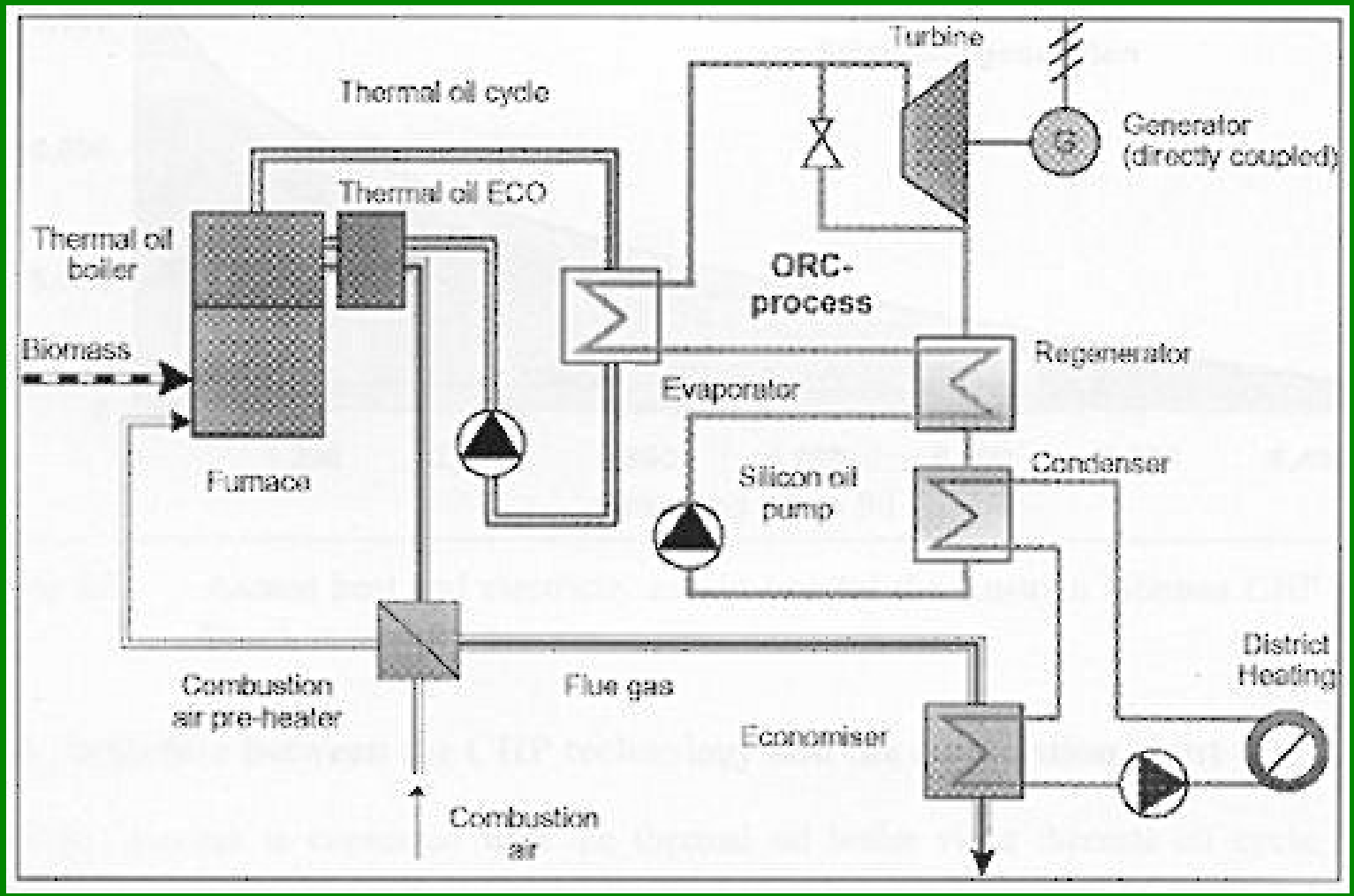
Power plants consist of

- Fuel storage
- Combustion unit
- Steam production
- Heat production
- Electricity generation
- Additional steam utilisation and/or condensation

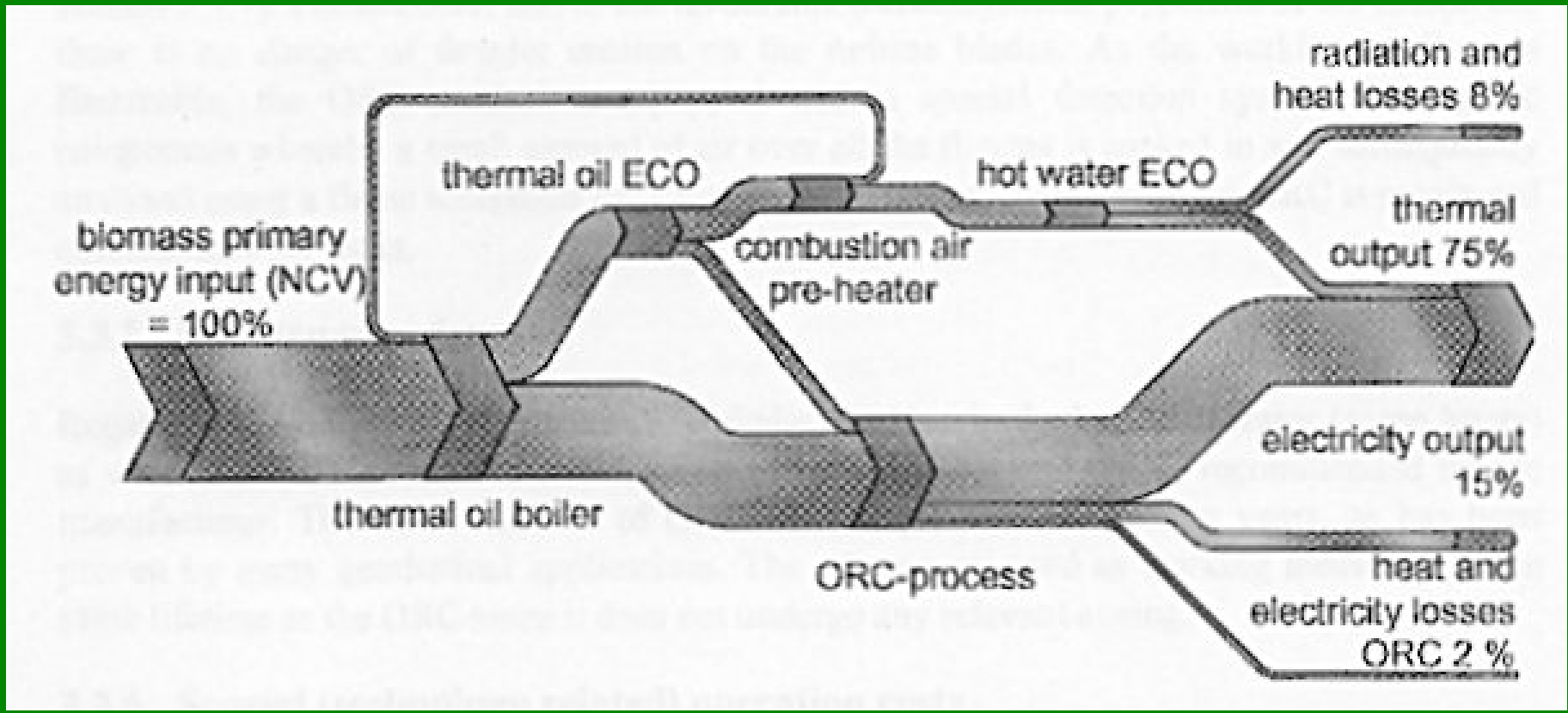
Biomass fuelled Heat Production

Biomass fuelled small District Heating Unit

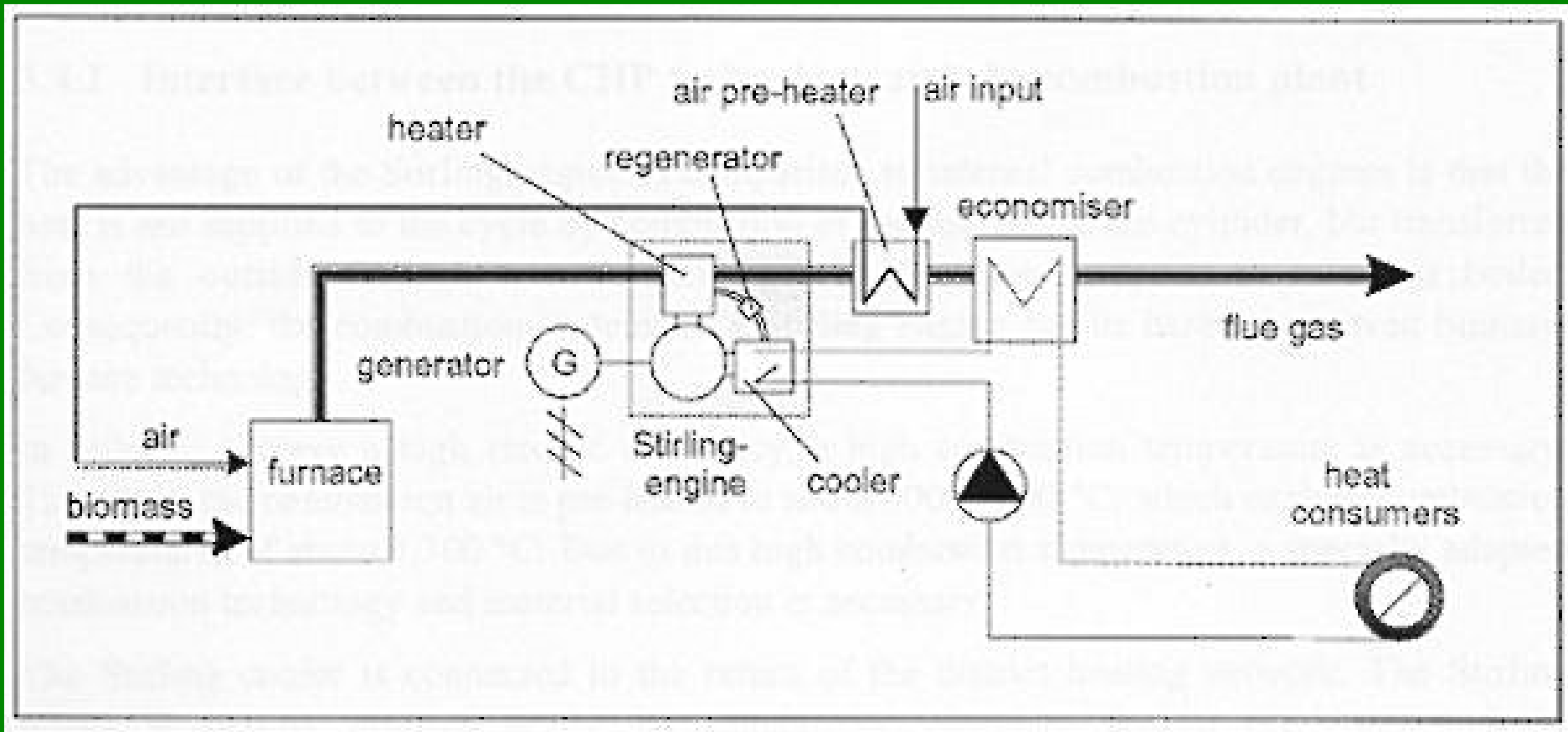
Small-medium scale power generation – Organic Rankine Cycle



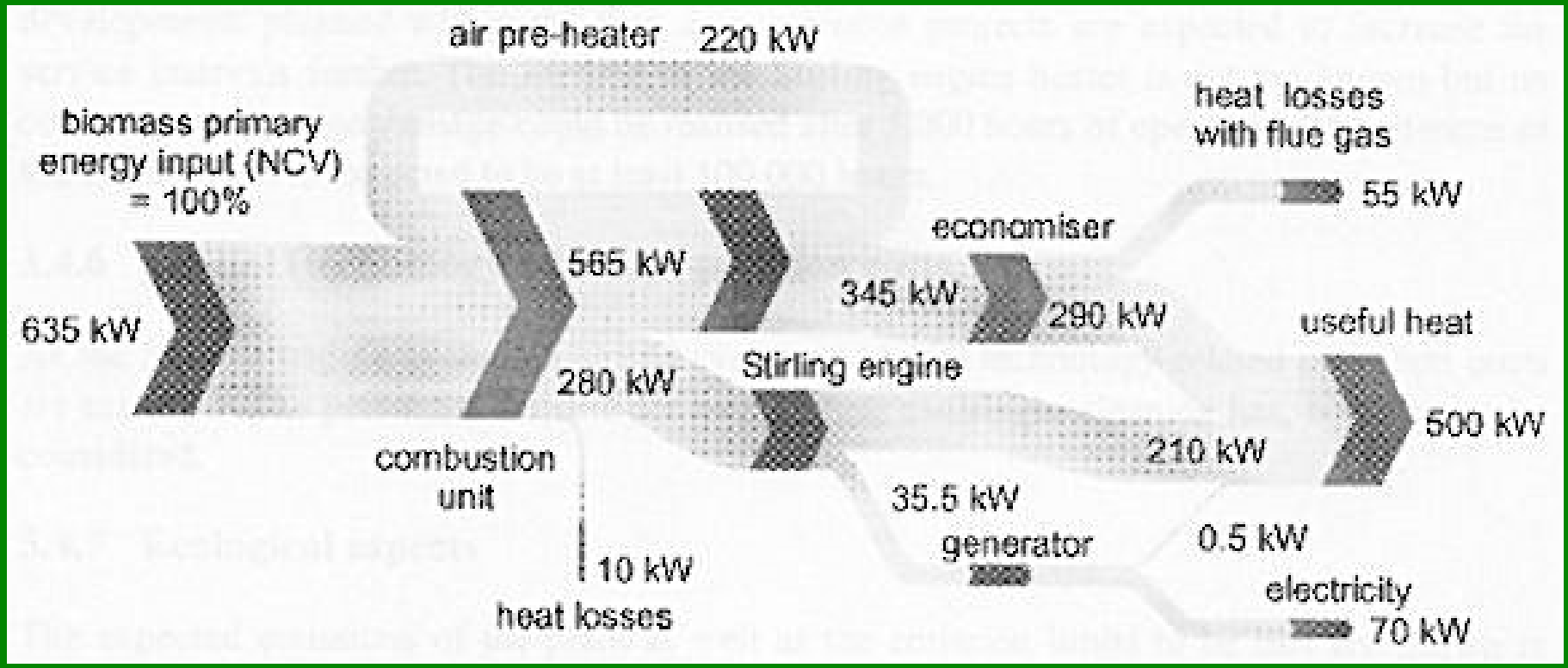
Small-medium scale power generation – ORC - Process



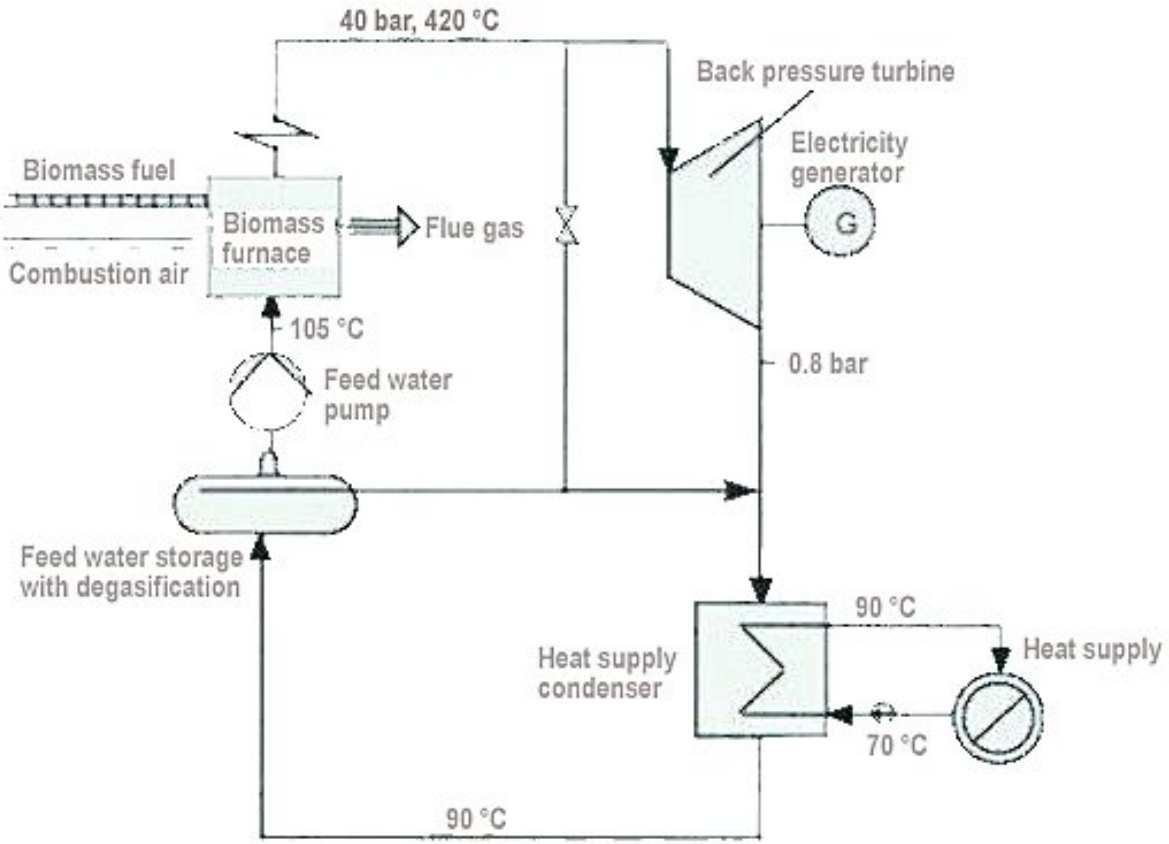
Small-medium scale power generation
Stirling Proeess



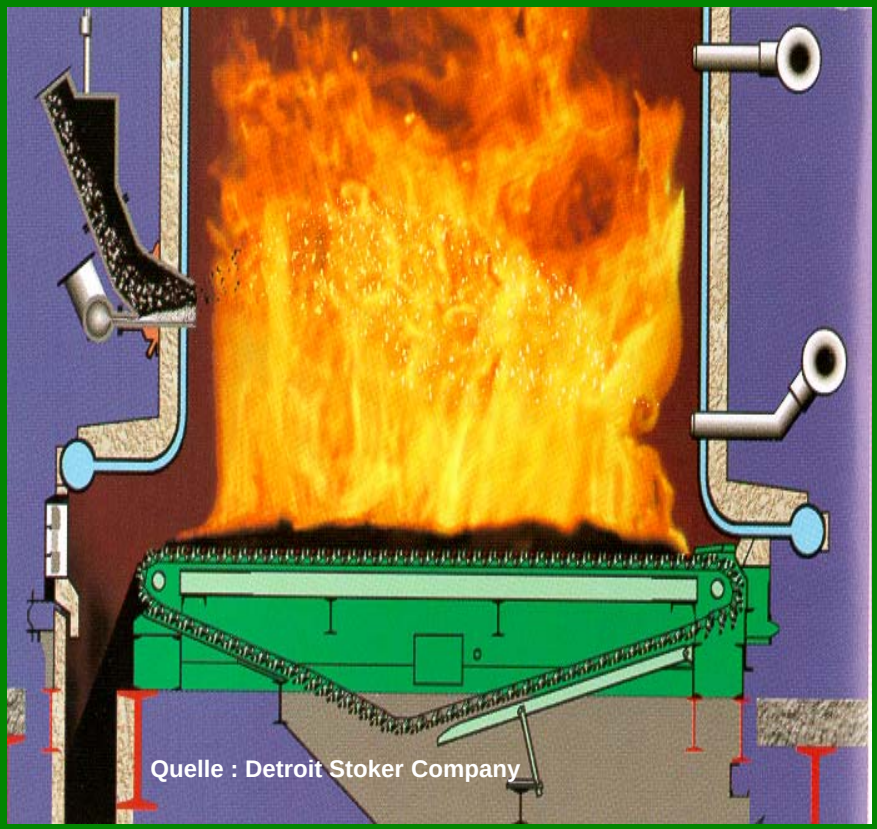
Small-medium scale power generation Stirling Proeess

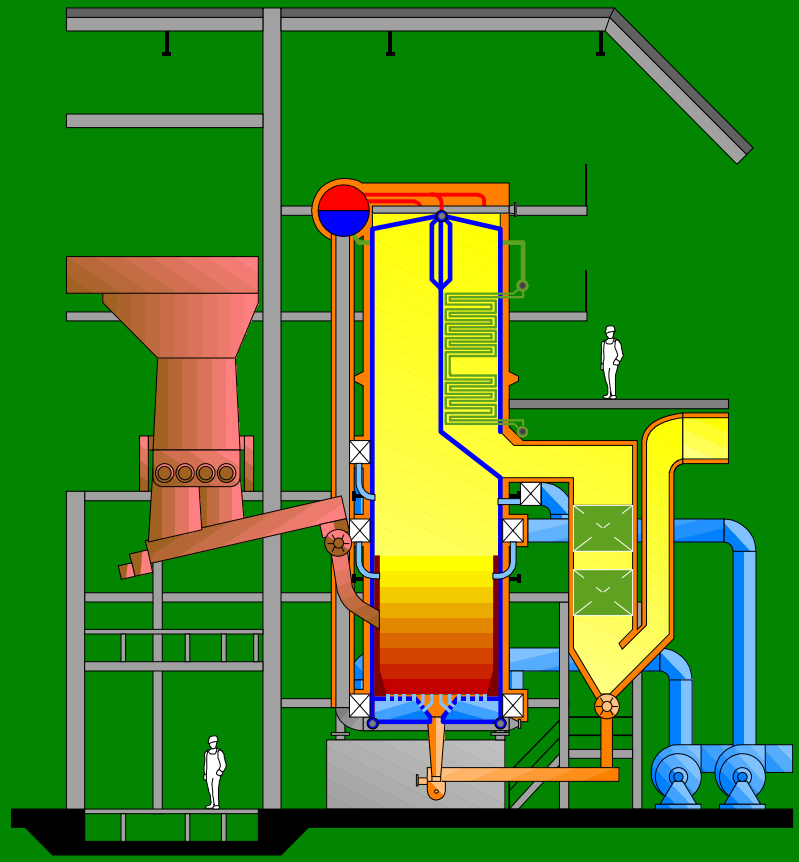


Medium/large scale conversion technologies



Medium/large scale combustion technologies





A general layout of CHP-power plants

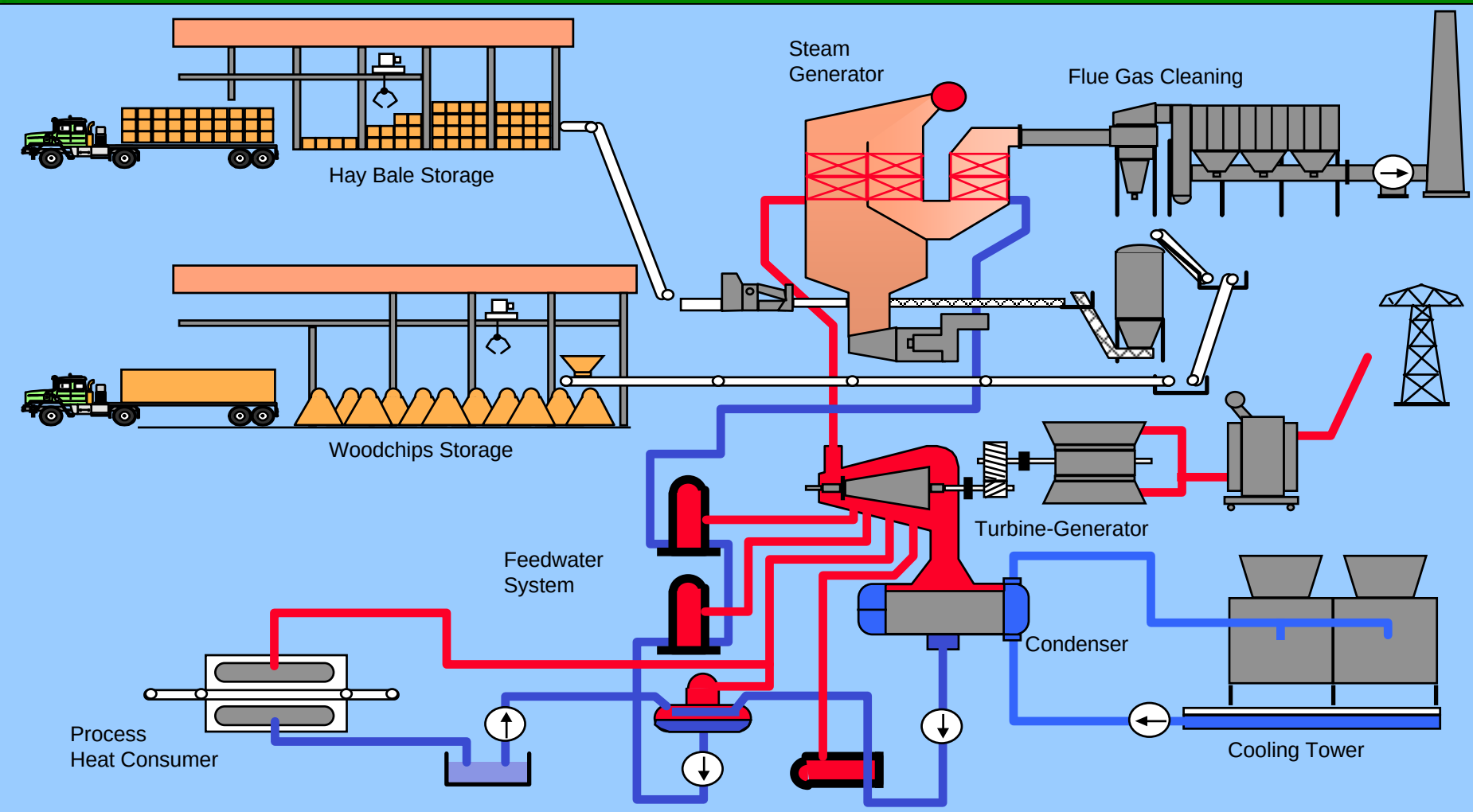
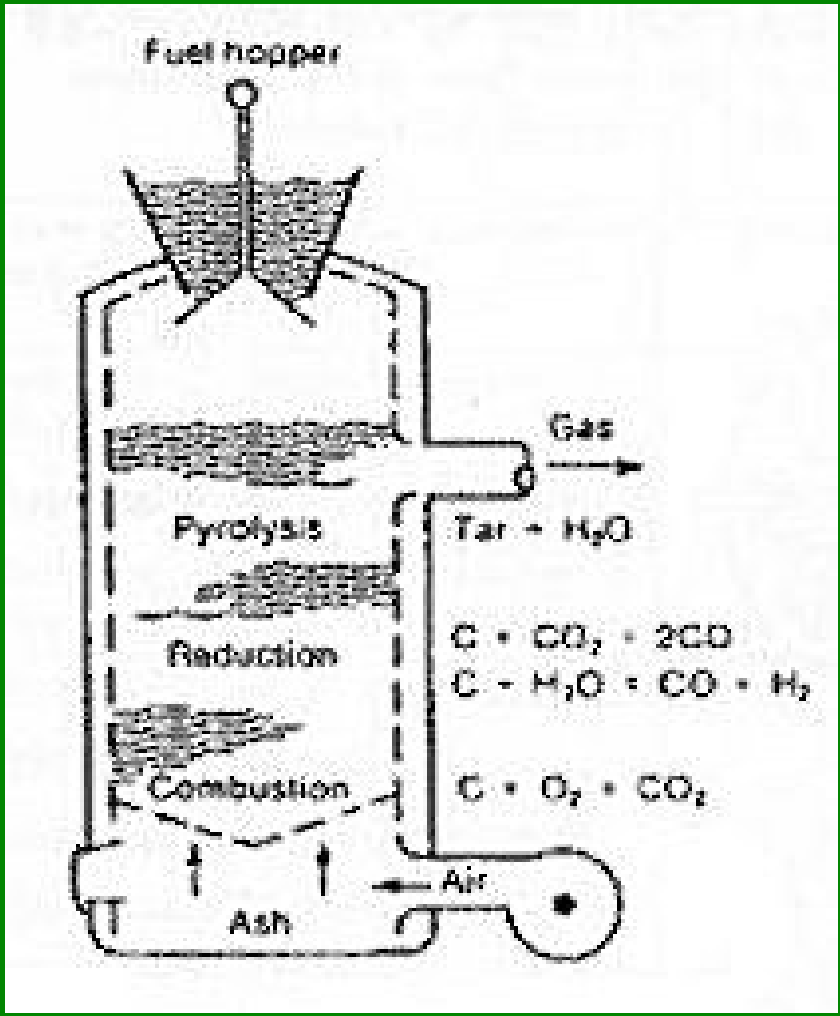
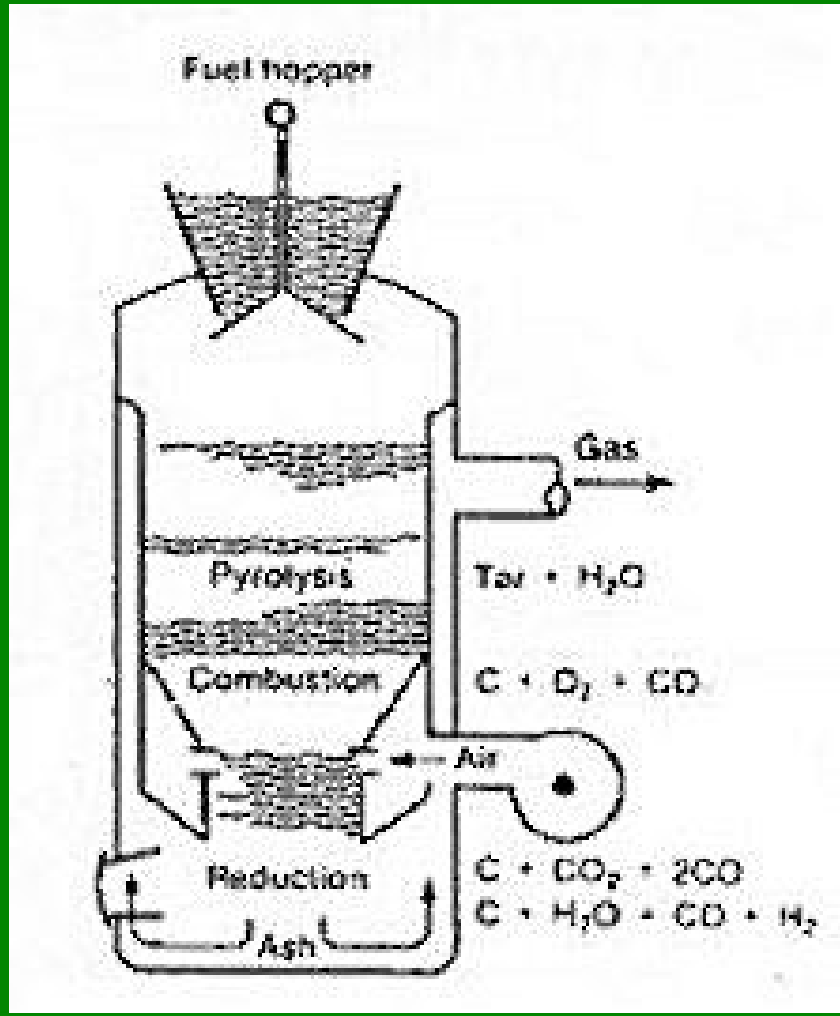


Image of a CHP power plant

Gasifier technology



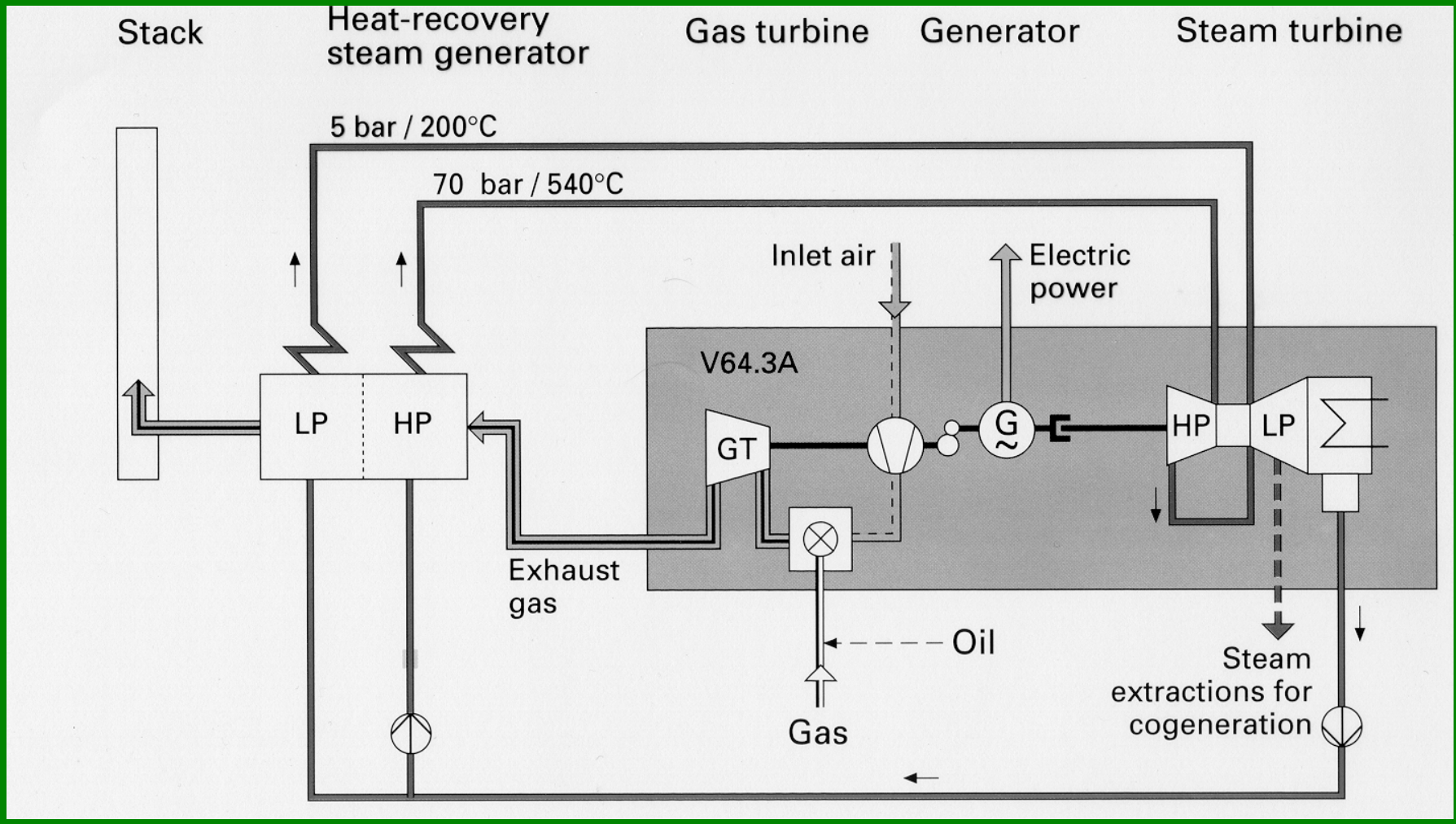


Gasifier technology

Biomass as gaseous fuel can be used

- stationary
  - by producer gas fuelled to engines and/or turbines
  - by producer gas fuelled to combustion units in order to improve efficiency and to reduce emissions level
- for transportation
  - by modified combustion engines and by hydrogen reformation/fuel cell systems
- distributed via feed-in

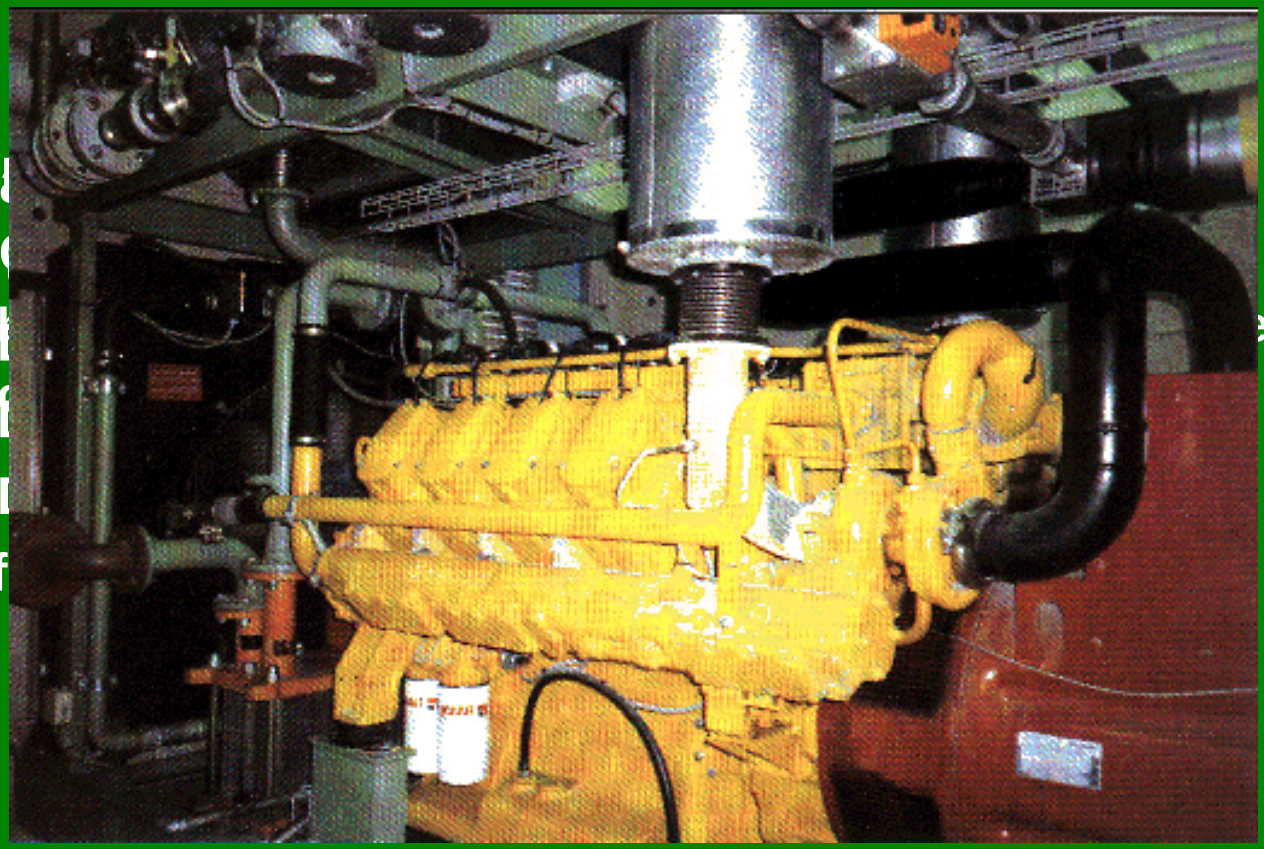
Novel solutions – Gas and Steam - cycles



A realised GaS – power generation unit

Biomass as a liquid fuel can be used

- stationa
  - for tr
  - by C
    - b
    - f
    - D
  - by f



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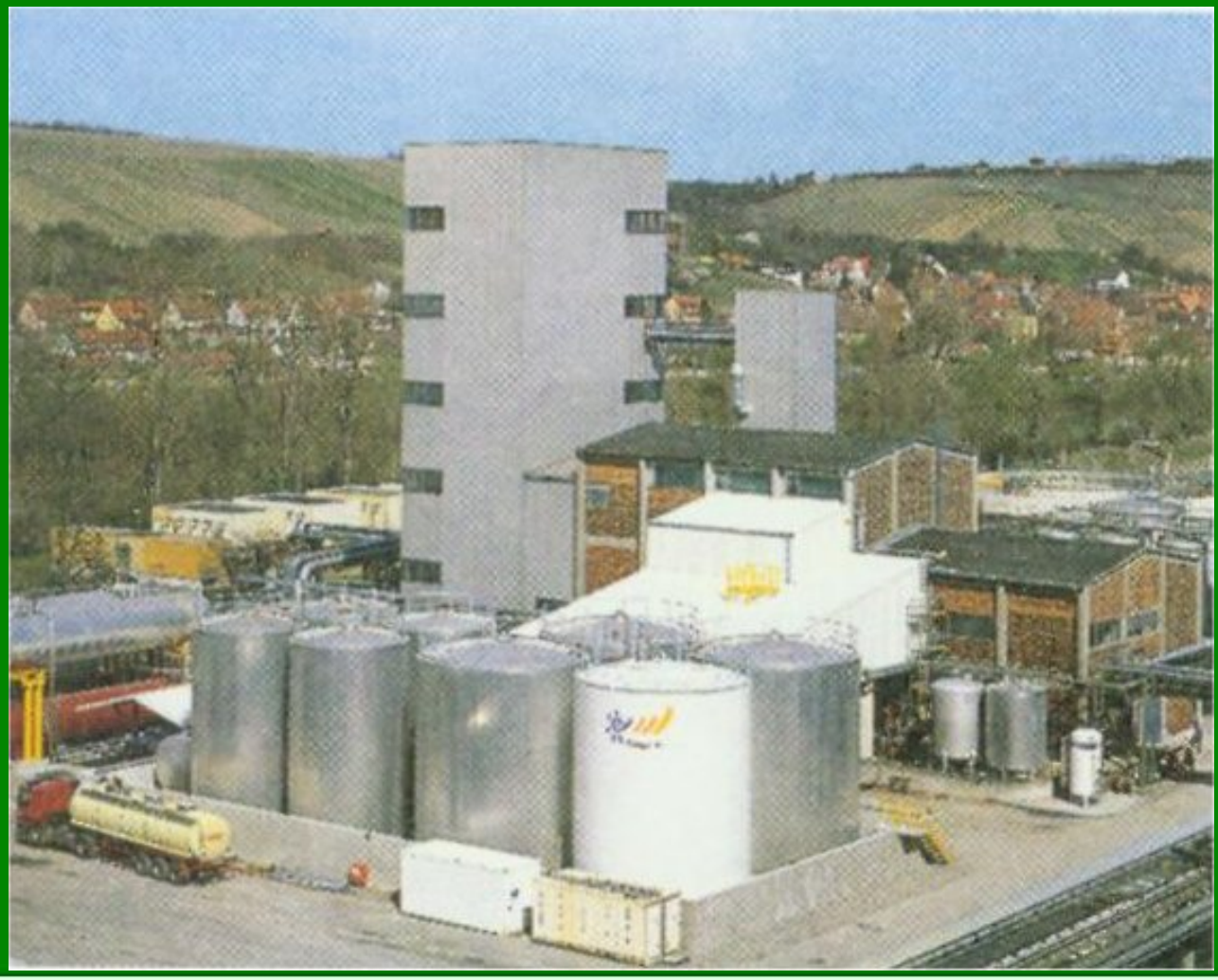
Biodiesel plant in Germany



Bioethanol plant in China

Utilisation of Biomass with high moisture content

- Anaerobic digestion is a well proofen means for producing gas from liquids containing solid biomass in small quantities, e.g. manure, sewage sludge, etc..
- The produced biogas consists mainly of methane and carbon dioxide.
- After desulphurisation the gas can easily be used.

Anaerobic Digestion Unit

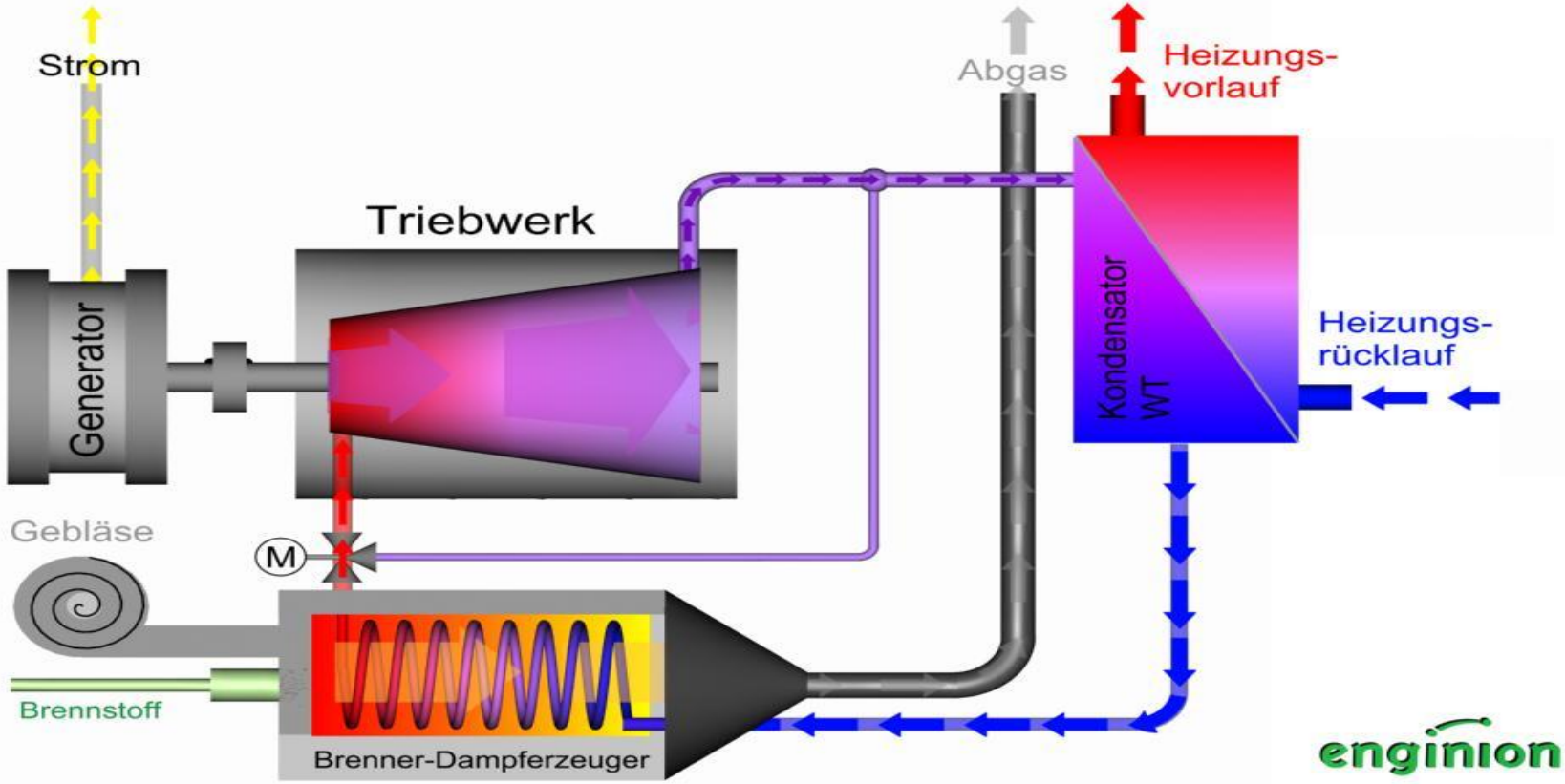
ENGINION – SteamCell technology

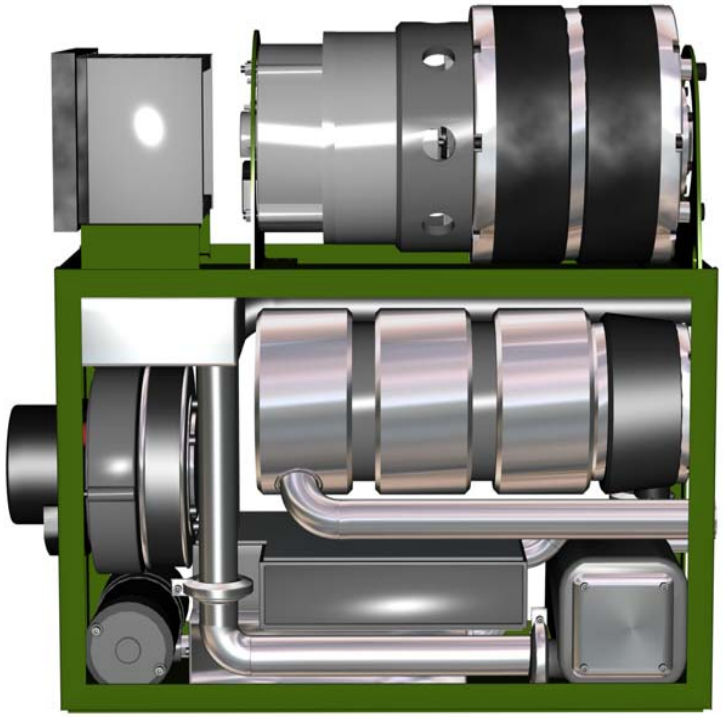
- **A SteamCell can generate both heat and power in an ideal combination**
  - **Modulating, low emission burner technology**
  - **Heat output used to convert a small amount of water into highly energetic steam**
  - **Unique drive mechanism to generate electricity**
  - **Special heat exchanger system to provide hot water**

  - **The SteamCell is capable of operating just like a conventional boiler**

  - **Heat from 2 to 25 kW**
  - **Electricity from 0.5 to 6 kW**

SteamCell Funktions-Schema





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Energy - the basis of all life

The contribution of RES to the world energy supply in 2040 – Advanced International Policy Scenario (Projections in Mtoe)

	2001	2010	2020	2030	2040
Total Consumption in Mtoe (IIASA)	10038,3	10549	11425	12352	13310
Biomass	1080	1313	1791	2483	3271
Large hydro	222,7	266	309	341	358
Small hydro	9,5	19	49	106	189
Wind	4,7	44	266	542	688
PV	0,2	2	24	221	784
Solar thermal	4,1	15	66	244	480
Solar thermal electricity	0,1	0,4	3	16	68
Geothermal	43,2	86	186	333	493
Marine (tidal/wave/ocean)	0,05	0,1	0,4	3	20
Total RES	1364,5	1745,5	2694,4	4289	6351
RES Contribution	13,6%	16,6%	23,6%	34,7%	47,7%

Energy - the basis of all life

RES contribution to the world energy supply in 2040 – AIP Scenario

Energy - the basis of all life

The perspective of growth rates of RES until 2040 - AIP-Scenario

	1996-2001	2001-2010	2010-2020	2020-2030	2030-2040
Biomass	2%	2.2%	3.1%	3.3%	2.8%
Large hydro	2%	2%	1%	1%	0%
Small hydro	6%	8%	10%	8%	6%
Wind	33%	28%	20%	7%	2%
PV	25%	28%	30%	25%	13%
Solar thermal	10%	16%	16%	14%	7%
Solar thermal electricity	2%	16%	22%	18%	15%
Geothermal	6%	8%	8%	6%	4%
Marine (tidal/wave/ocean)	-	8%	15%	22%	21%

Further information through:

WIP – Renewable Energies

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