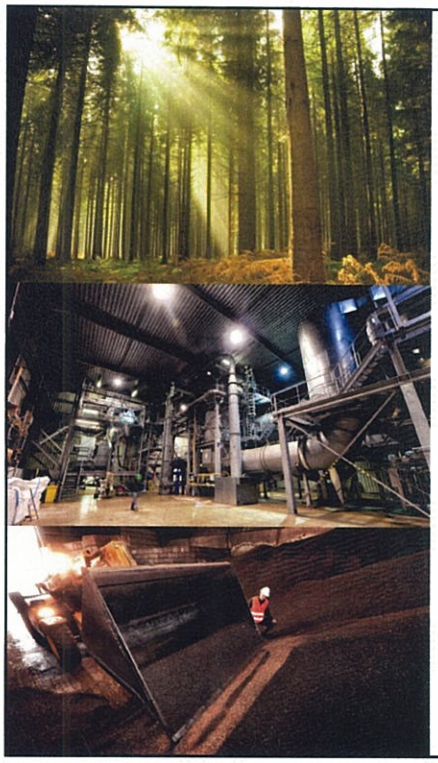


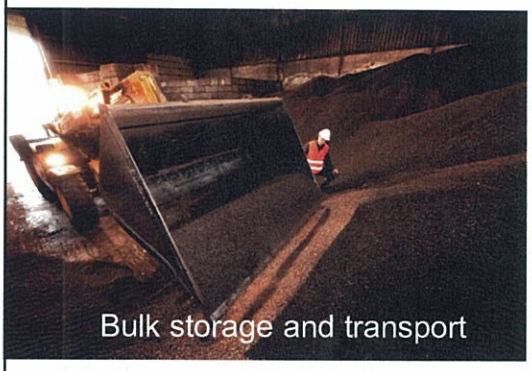
Torr-Coal Group

We turn woody biomass into a carbon neutral bio-coal

The challenge: make biomass tradable

Store and utilizes it like fossil coal

Using existing fossil coal infrastructure



Turn biomass into a comparable product as fossil coal but without the carbon footprint…

We produce bio-coal since 2010

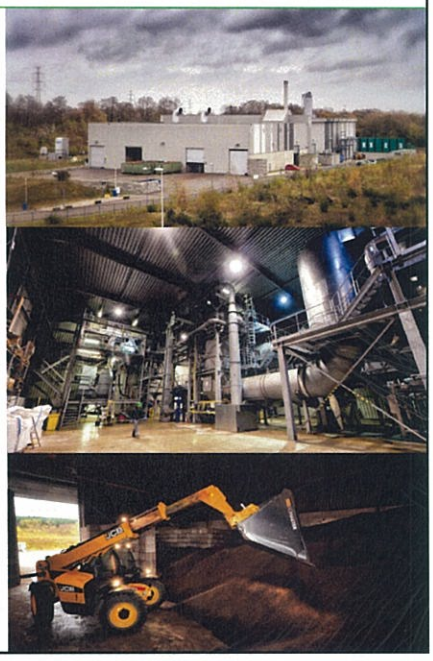
- Commercial scale plant
- Operational since October 2010
- Located in Dilsen-Stokkem (Belgium)
- 15 Fte

- Indirectly heated rotary drum

- Powder and pellet production
- In accordance with newest ISO DIS 17225-8

- Output: 30,000 ton/y bio-coal
- Input: 90,000 ton woody biomass (wet content +/- 50%)

- Capex +/- 17 million Euro
- Project IRR 15%



We produce a high quality bio-coal

Particle size	0,1-2 mm
Bulk density	> 250 kg/m³
Moisture	< 3%
Ash	< 4%
Calorific value (lhv a.r.)	22-26 GJ/t
Volatile (daf)	50-70%

Pellet size	d 6 mm, l < 40mm
Bulk density	> 650 kg/m³
Moisture	< 8%
Ash	< 4%
Mechanical durability	> 96,5%
Calorific value (lhv a.r.)	21,5 -23 GJ/t
HGI (own method)	> 40
Volatile (daf)	50-70%

We convert biomass waste into bio-coal

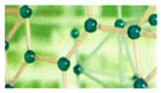
Residual wood

Torrefaction process

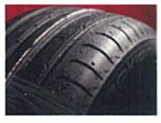
Bio-coal

- Increase energy density
- Reduces volume
- Makes it homogeneous
- Makes it easy to store
- Makes it easy to pulverize

Green chemistry



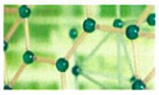
Bio-products



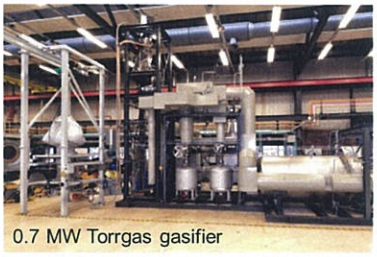
Renewable energy

We sell bio-coal in 3 markets

Green chemistry



- Syngas
- Bio char
- Activated coal



0.7 MW Torrgas gasifier

Bio-products

- Carbons

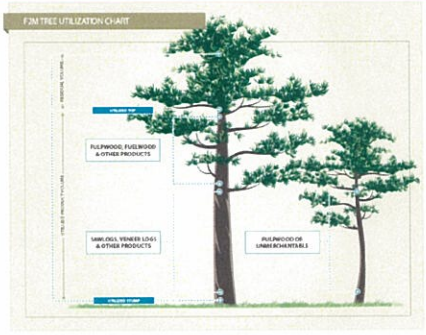
Renewable energy

- Energy plants
- District heating
- Premium market

Hanasaari power plant (Helsinki Finland)

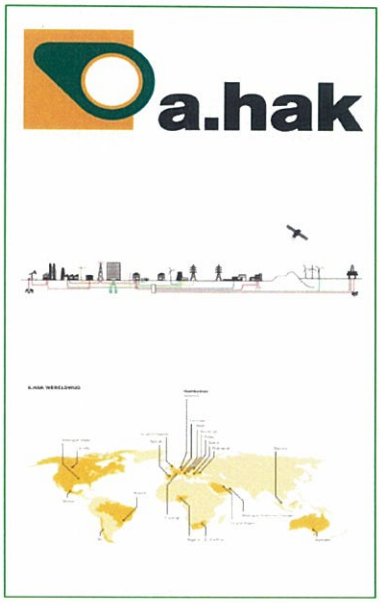
We help you to produce bio-coal

- Develop business case
- Optimizing input and output parameters
- Input: maximizing the value of a tree
  - We only use residual wood
  - Tops, balances, slaps and bark
- Output: maximizing bio-coal off-take possibilities
  - Renewable energy
  - Bio based products
  - Green Chemistry
- Make client specifications
- Engineer system
- Supply and commission Torr-Coal technology
- Train how to operate a Torr-Coal plant
- Help to optimize Torr-Coal plant



We develop plants worldwide

- Torr-Coal Group
  - Torr-Coal Technology BV
  - Torr-Coal International BV
  - Torr-Coal Production Centre BV
- Found in a.hak strong shareholder
  - EPC contractor
  - 20 branch offices worldwide
  - 3.500 Fte / 500 million Euro turnover
  - To design, build and maintain torrefaction plants worldwide
- Torr-Coal plants under development
  - Russia, in partnership with Gazprom (252k ton/a)
  - Indonesia, in partnership with ARSARI Enviro Industri (320k ton/a)



Any questions?

If you want to visit our commercial scale production plant in Dilsen-Stokkem, to see our torrefaction capabilities yourself? Please send an e-mail to info@torrcoal.nl

Torr-Coal Group

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What is bio-coal?

Biocoal is a solid fuel made from biomass by heating it in an inert atmosphere. The result is either charcoal, or if the process temperature is mild, a product called torrefied wood.

Charcoal and torrefied wood can be called by common name bio-coal.

Compared to untreated biomass bio-coal has several advantages. It has high energy content, uniform properties and low moisture content.

Bio-coal can be used in coal fired power plants, which have difficulties with other biomass based fuels, such as wood chips.

If bio-coal raw material originates from sustainably managed forests, the product is carbon neutral. The growing new tree generation captures the same amount of CO2 from atmosphere that is released in the manufacture and combustion of bio-coal.

Bio-coal can be made from nearly all kind of organic materials. Wood is the most important raw material, but also straw, peat bones and even manure can be used.

Most important woody biomass sources are:

- Waste wood residues from wood producing industries (pulp, sawmill, ...)
- Solid municipal waste: A/B/C wood
- Energy crops (willow / poplar)

What is carbonization?

Bio-coal is made with a carbonization (also called pyrolysis) process, where biomass is heated in the absence of oxygen. Heating causes thermal degradation, producing various gases and solid material.

If the highest temperature of carbonization is above 400 °C, the solid material is charcoal, and contains mostly pure carbon. If the temperature remains between 200 and 300 °C, the solid product is called torrefied wood, and the process torrefaction.

Carbonization of biomass produces various gaseous products; part of these can be condensed into liquid called pyrolysis oil. The non-condensable gases contain mainly carbon dioxide, carbon monoxide and hydrogen. Both non-condensable gases and pyrolysis oil can be used as fuel. This fuel is employed as energy supporting the torrefaction process.

Temperature is most important process condition in carbonization. Most bio-coal properties, such as heating value and ash content depend on temperature. Also yield depends on temperature. In mild torrefaction, where temperature is 230 °C, the yield can be over 90 % percent. Increasing temperature to 900°C decreases the yield to 25 %

The energy density of torrefied wood is significantly better compared to chipped forest residue, since moisture content of wood fuel can be circa 50 % after harvesting. Moisture content of torrefied wood is much lower, which improves energy density

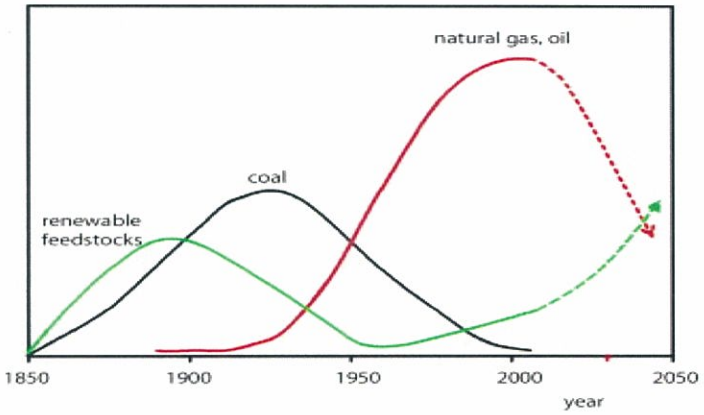
Woody biomass is a bio-renewable

Since the beginning of civilization, biomass has been a major source of energy for the world's people. Biomass is the primary source of energy for half of the global population. In the developing world, wood biomass is a major renewable energy source, representing a significant proportion of the rural energy supply. At present, bio-energy is the most important renewable energy option and will remain so the near and medium-term future. It will therefore play a crucial role in integrated systems of future energy supply and will be a valuable element in a new energy mix. In the past decade, the number of countries exploiting biomass opportunities for the provision of energy has increased rapidly, and has contributed to making biomass an attractive and promising option among other renewable energy sources. Biomass has the potential to become the world's largest and most sustainable energy source and will be very much in demand.

The annual global primary production of biomass is equivalent to the 4,500 Exajoules (EJ) of solar energy captured each year. A mere 10 percent increase in the efficiency of biomass production through irrigation, manuring, fertilizing and/or improved management through the cultivation of idle land, would create energy equivalent to the total current global energy demand. A prerequisite for achieving the great potential of bio-energy in all regions is replacing the current inefficient and low-intensive management systems with best practices and technologies.

History in chemical industry

Use of renewable feedstock in petrochemical industry.



Raw materials basis of chemical industry in historical perspective.
Source: Lichtenthaler/Peters (Technische Universität Darmstadt)