While coal itself is polluting, biomass can be processed into coal-like substances that provide a similar but cleaner energy output

Biocoal is the goal

Unlike wind and solar, biomass can be used to produce renewable energy all year round. Different materials, from residues (straw, hedgerows) to dedicated biomass crops (grass, maize, king grass), can be burned to produce heat and/or power. Biomass from agricultural land gives higher yield per year per acre compared to forest waste (between two and five times), and can also be used as part of the land use system, through intercropping for example.

Before such biomass can be fired in a coal burner, it has to be treated to ensure the inhomogeneous burning elements are converted into a homogeneous burnable energy source like coal. The conversion is mostly a rejection and cracking of some parts and using the off-gassing energy during the treatment process.

Coal can be stored outside all year round, regardless of the weather conditions. In order to store biomass in similar conditions, it has to be treated in a precise manner. There are different ways to meet these requirements with biomass.

Biomass from residues

Straw is one of the most popular sources for agricultural fibre. Many projects and technologies have tried to make straw a competitive fibre source, but unfortunately the transport costs for straw and the existing biomass-to-energy conversion systems are not competitive with other sources. To make straw work as a fibre source, the system described in figure 1 can be used to fuel the market with renewable energy. The system is complex, but the use of all parts of delivered energy is the key to a successful project.

Figure 1 presents a system to produce coal-like fuel while generating natural gas as a by-product. This system can be interesting for farmers seeking to generate additional income out of existing land use systems. The advantage of this method is the logistic ease of transporting material to and from a plant. The use of old biomass sources with new technologies will bring additional benefits to agricultural businesses.

Dedicated biomass crops

Land use systems are flexible when yearly crop rotation is used as the standard procedure. With this method, a part of the land or, in some areas, all available land (land conversion from unused areas) can be used to produce dedicated biomass crops. In order to ensure that these systems are sustainable and ecological, nutrients from the biomass need to be reused to reduce costs and dependence on chemicals or other synthetic fertilisers.

Only an ecological and sustainable land use system can succeed in providing these benefits in the long run. Soil health should be used as an indicator in new systems when measuring the benefits of energy production from new agricultural land use.

Figure 2 represents a system for using agricultural fibres in the production of treated biomass. This treated biomass can be used to fuel existing coal plants and carbonize treatment residues, such as fast burning elements and most volatile organic compounds (VOCs). The chart gives an overview of a new washing and dewatering system, which can be used to clean and reduce water content in agricultural fibres before the carbonization treatment.

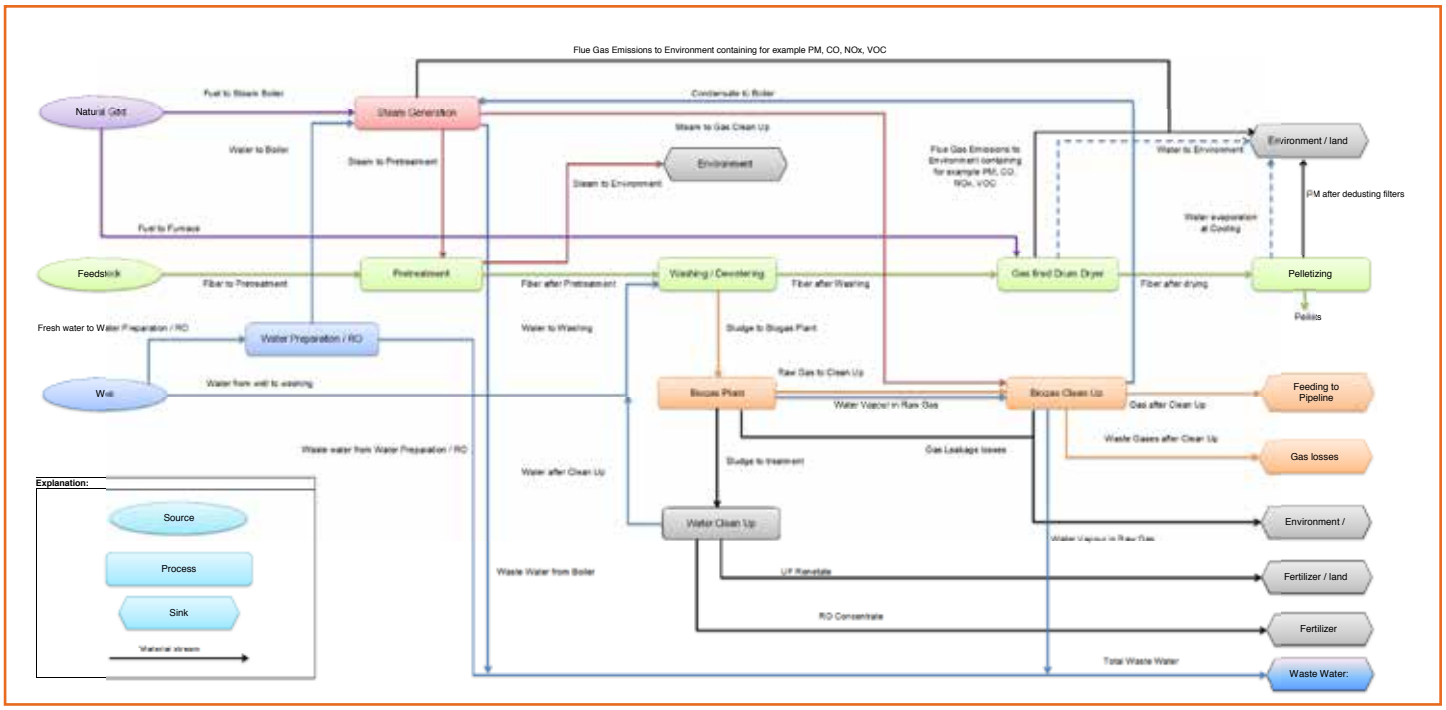

Figure 1: A system for producing solid carbonized fuel and natural gas

Leaching the material before drying reduces nutrient content and saves energy costs during the drying process. The nutrients, as described before, can be used as fertiliser, and their amounts are presented in figure 3. This data shows that up to 90% of the nutrients collected from harvested fibre can be recycled before using the fibre for energy production. This system is sustainable and cost-efficient for all fresh-harvested biomass.

Dry fibre to black fuel

Coal-fired plants usually handle ash contents from 5 to 45%, depending on the used technology. The differences between different biomasses manifest in the combination of nutrients in the residues. In dedicated biomass plants, the portion of biomass left behind as ash usually never exceeds 20%. To combine the low ash content and the missing minerals for low ash melting point, additives can be helpful. Treating biomass and mixing additives into the fibre will result in a solid fuel, which is close to coal in its burning characteristics.
The aim and challenge, then, will be to run this conversion system at a low operating cost, while handling higher volumes of ash during production and using low-grade biomass as a cheap fibre source. Therefore, briquetting instead of pelletizing can reduce equipment wear during densification and reduce operating costs.

Results

As all the presented systems show, technologies for treating any biomass are available. However, these more complex systems present challenges, and they can only be successful if sustainable energy, produced in an ecologically friendly way, is the target market for their products. It is at the moment impossible for these technologies to be competitive with fossil fuels without including the external effects of new biomass sources into the economics of existing fuel supply chains. These external effects of new biomass-to-coal systems include the increasing land use in set-aside areas and agricultural areas left unused due to unprofitable land use systems or regulations for food production.

The starting point in the transition to a fossil energy-free future will always be the 'traditional' biomass, or wood. The new fibre sources, with new technologies for conversion to coal-type biomass, provide flexible solutions for non-forested areas and the higher yield per acre will bring more energy to the market. As of today, the biomass market focuses on using wood fibre and low-grade residues.

Only a few projects are trying to install sustainable and ecologically friendly energy conversion systems to reduce the use of fossil energy. The pressure on the industry to invest in renewable energy projects is still low as the oil and gas prices remain low and CO_2 credits are cheap. If the use of fossil energy is radically reduced or banned altogether from the primary energy market, the demand for biomass will grow. Only high-yield land use systems can be successful in the long run, and the presented examples are only the most common of new land use systems. The combination of special plants and new technologies will be the key to supporting the energy market in the future.

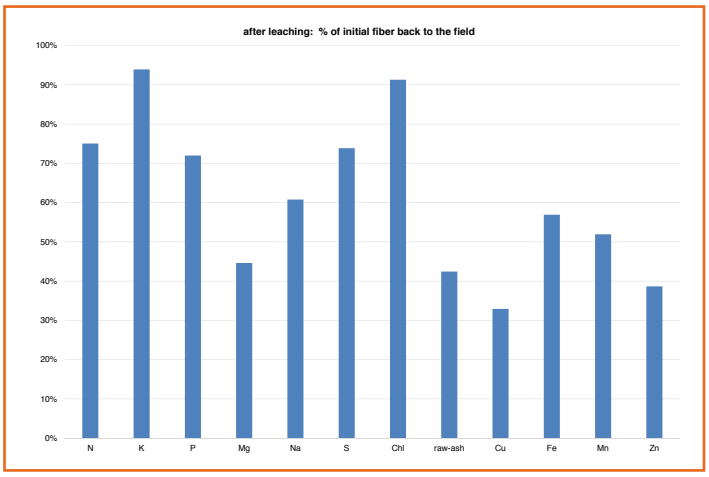

Figure 3: Nutrients returned to the field

For more information:
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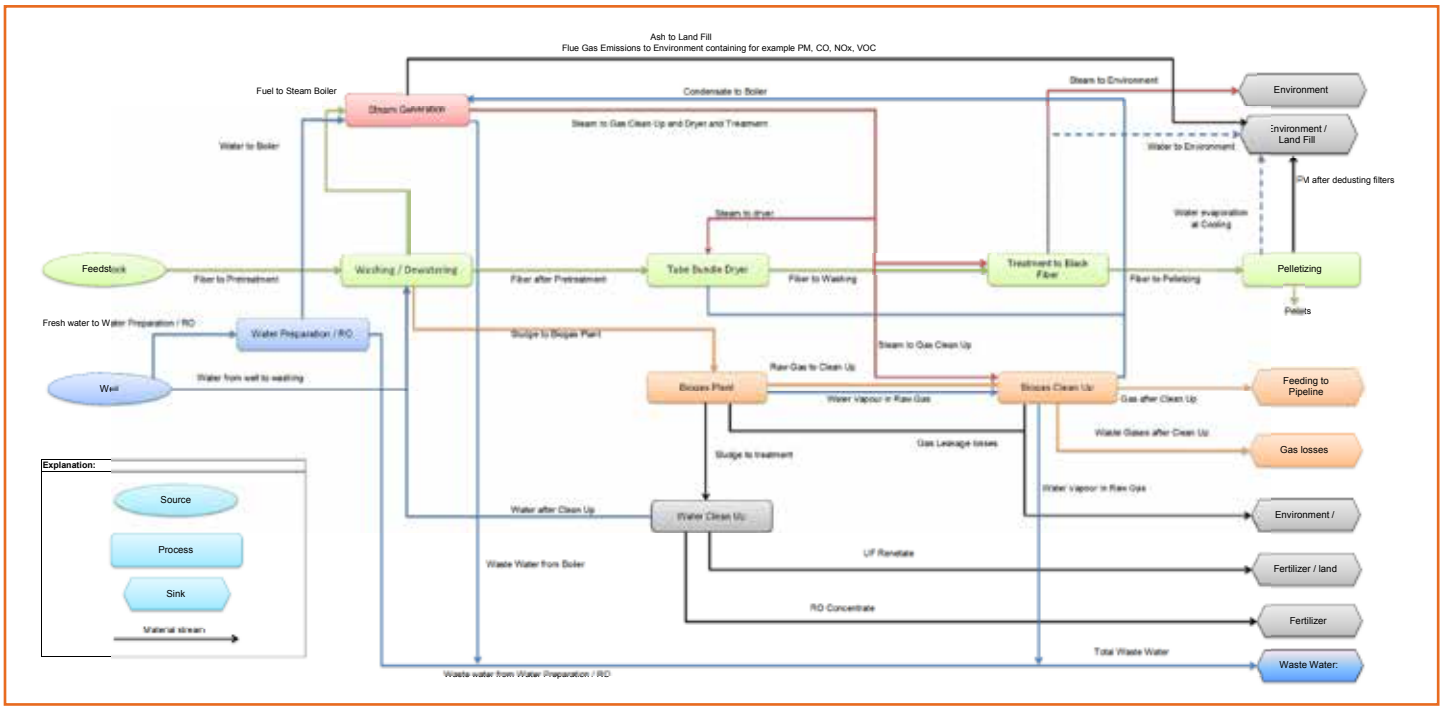

Figure 2: Combination of leaching and carbonization treatment