gasification

what is it?

It's turning biomass (e.g. wood chips and offcuts) into usable gas. If wood is heated but starved of oxygen, so that it doesn't burn with a flame, gas is released and char is left behind (as in charcoal production). This wood gas (called 'producer gas') has a high calorific value that can be transformed into kinetic energy by combustion in an engine cylinder, and into grid-independent energy if attached to a generator. Heating without oxygen is called pyrolysis - which is just a stage in, and not synonymous with, the gasification process.

Gasification is not new. Coke/coal gasification in the 1850s was followed in the early 20th century by systems that could accept wood scraps and agricultural residues, reaching a technological peak during the 1930s and 40s. It changes a bulky fuel into a gas that is easier to transport, and burns cleaner and hotter. Internal combustion engines (both spark and compression types) can be converted to run on producer gas, and during WW2, when there were shortages of petrol and diesel, wood-fuelled vehicles became relatively common. Their use declined when oil became cheap, but some countries - particularly in Scandinavia - continued to use the technology. Interest has returned because of global warming and future fuel insecurity.

Small-scale gasifiers can potentially turn any carbon-based waste into energy. Large-scale gasification for turning municipal waste into energy is subject to increasing investment due to the bad press that incineration has received, and govt. subsidies for waste-to-energy systems. So far, the track record of large-scale systems is poor, due to the variable nature of the waste, with numerous system shut-downs for exceeding emission limits or poor operational performance.

Huge amounts of sawdust & wood chips are generated by the logging/lumber industry; it's often freely available, as it's expensive to landfill.

10kW combined downdraft biomass gasifier with engine and generator.
www.allpowerlabs.com

what are the benefits?

Gasifiers have an advantage over wind and solar, as they provide power/heat on demand and aren't limited by seasonal/diurnal variations in supply. The systems operate like a car with a fuel tank of wood chips. When the engine runs faster, the wood is used up more quickly; more slowly, and it will last as long as needed. They can be more efficient than biomass boilers as they have no water-heating requirements for energy transfer. Gasifiers produce lower levels of NOx and SOx pollutants than combustors. The char-ash by-product can be used as a soil fertiliser/conditioner.

Biomass is only sustainable if plant regrowth equals removal, and if no associated fossil-fuel energy is used. Due to the large volumes required, demands on suppliers to be reactive to market requirements, and the extra costs involved in locking in large areas of space, biomass supplied to power stations is usually force dried in large fan-assisted ovens, pelletised, and transported internationally. Small-scale use of bio-waste does not have these associated carbon inputs, and it doesn't require the use of quality agricultural land.

Small-scale gasifiers will be cost effective where there is waste wood for free. When timber is harvested, anything other than heartwood is chipped anyway, and left in situ or landfilled. It has zero or negative value since landfill disposal is costly. This has community enterprise potential, using of local authority waste. In the developing world, gasifiers can provide something that the grid can't - reliable electricity for industry.

what can I do?

Biomass gasification reactors are simply steel vessels filled with wood chips. With one or more small openings to permit some air to enter, they are connected directly to an engine, and the engine suction pulls the gas through. They need no external water, electricity or gas, as they self-sustain their internal temperature. Reactor designs have changed little since the 1920s, and are based around three main types: updraft, downdraft, and cross-draft. There are also fixed and fluidised bed gasifiers (air or steam gasification), but these are industrial-scale systems. Downdraft, fixed-bed gasifiers are the most widely used, as they produce high-purity gas with relatively low quantities of tar.

For anyone with basic fabrication skills, small biomass gasifiers can be self-built, and full details of sizings and components can be found online. There are a number of companies offering commercial systems - such as GEK, Volter and Ankur. These are not at present, 'push-button', low-user interaction appliances, but they're getting there. Made from sturdy basic components, gasifiers are at present much like a classic car, which needs routine maintenance to ensure reliability, but could last a lifetime. Specialist biomass gasification consultants are rare.

Gasifiers are proven to work with wood chips, but poor-quality wood chips can lead to problems if the set-up is not right. In particular, before buying a system, look for the small print about what the feedstock requirements are, since some (but not all) systems will stipulate wood chip moisture levels below that which can be achieved naturally. Fines content can also be a problem. Outside of design specification feedstock range, temperature in the reactor varies and tar comes through in the gas, which can clog engine pipework. Some systems use water scrubbing to clean tar from the gas, which can result in high disposal costs throughout the lifetime of the system. Others use basic wood chip filters, which work effectively.

Pickup with gasifier tank on the back. It's filled with wood scraps and the gas is piped to the engine.

Wood gas comprises about 20% carbon monoxide, which is fatal if inhaled. However, considering that oil and petrol are highly flammable, carcinogenic liquids, producer gas just poses a different hazard. Operating temperatures inside the reactor are between 800-950°C for optimum clean gas. The gasifier reactor is silent when operating, but the engine will be noisy. They're legal to own and operate, and as they only produce smoke at start up and shut down, they can be used in smokeless zones. This is just for stationary gasifiers in the UK, not for vehicles - although they are legal in other countries.

Wood gas generators are stand-alone, but can be grid-tied. In the UK, they are presently not eligible for feed-in tariffs, but system owners can get credits from ROCs and income from the Renewable Heat Incentive, although there are caveats.

resources

- see lowimpact.org/gasification for more info, training, products / services, links & books, inc:
- Andrew Rollinson, *Gasification: succeeding with small-scale systems*
- UN Food & Agriculture Organisation, *Wood Gas as an Engine Fuel*
- Paul Andrulis, *The Amazing Wood-gas Camping Stove*
- nrel.gov/docs/legosti/old/3022.pdf - *Handbook of Biomass Downdraft Gasifier Engine Systems*
- build-a-gasifier.com - good site with lots of plans, kits, links and old books
- mdpub.com/gasifier/ - Michael Davis's great page about his home-made biomass gasifier
- lowtechmagazine.com/2010/01/wood-gas-cars.html - great article on wood gas vehicles
- vedbil.se/indexe.shtml - blog about a journey around Sweden in a wood-fuelled vehicle