Regarding your question related to the disposal of wind turbines, you should know that at the moment there are several ways of dealing with the end of life of these machines: landfill, incineration, re-use and recycling.

First of all, almost all the components of wind turbines have very high recyclability rates, for instance VESTAS has calculated that the average recyclability across the components of a V80-2.0MW wind turbine is approximately 85%. The components contributing to recyclability relate to metal parts manufactured from iron, steel (attaining almost 100%), aluminium and copper. The V80-2.0MW turbine is constructed from around 88% metals. The only parts of a wind turbine that are harder to recycle are the fibre-reinforced plastics (FRPs).
http://www.vestas.com/en/about-vestas/sustainability/sustainable-products/life-cycle-assessment/available-life-cycle-assesments.aspx

The 4 disposal methods:

1) The first one is **landfilling**, but a lot of countries are trying to reduce their waste volumes and therefore adopt laws to forbid or at least discourage landfill disposal. Germany, for example, introduced a landfill disposal ban on glass fibre-reinforced plastics in June 2005, due to their high organics content (30%) such as resin and wood. In other countries, such as the UK, landfilling is still possible but the tax per ton of material can discourage and direct the owner towards other options.

2) Another disposal method is **incineration**, which is one of the most common solutions. Its advantage is that there are already numerous facilities in place (incineration plants) and that it can be done at attractive prices. The incineration is done in the so-called combined heat and power (CHP) plants; the heat from incineration is used to create electricity, as well as for district heating systems. However, 60% of the scrap is left behind as ash after incineration. Due to the presence of inorganic loads in composites, this ash may be pollutant, and is, depending on the type and post-treatment options, either dumped at a landfill or recycled as a substitute construction material.

3) The third one is **re-use.** Its advantage is that it has an economical value but it is hard to apply due to the different types of fibres, the purity of the materials.

4) One alternative to the above-mentioned methods is **recycling**, either material recycling or product recycling. For material recycling, only 30% of fibre-reinforced plastic waste can be re-used to produce new FRP. Most of it goes to the cement industry as filler material. Product recycling takes the form of re-powering, i.e. replacing old turbines by newer, more efficient ones. Re-powering happens after approximatively 10 years, as a result of government policy, as it occurred for instance in the Netherlands, Denmark and Germany. However, the designed lifespan of a wind turbine is 20 years. Many of these used wind turbines could still function properly for a number of years. Windbrokers is a private Dutch-owned company involved in the second-hand wind turbines market.
http://www.windbrokers.com/

Examples of EU companies that have developed methods for rotor blade recycling:

1) **Geocycle/Zajons solution (co-processing)**

Holcim AG/Geocycle together with Zajons developed a new recycling system. The idea was to create an industrial waste disposal solution for large components of fibre-

reinforced plastics (glass fibre and carbon fibre) which ensures a complete thermal and material recovery during the production process of cement clinker. According to assessments made by German experts, prior to the Zajons/Geocycle solution there was no practicable disposal method for rotor blades mainly because of inadequate logistics, health & safety and environmental risks (dust and solvent emissions).
http://www.zajons-logistik.de/
http://www.dewi.de/dewi/fileadmin/pdf/publications/Magazin_36/02.pdf

2) ReFiber solution

ReFiber ApS has developed and patented a concept for recycling glass fibre and carbon fibre. The ReFiber process makes use of the pyrolysis method (thermal treatment); this recycling concept occurs with the recovery of energy (the gas obtained throughout the process is burned in CHP plants used in district heating) and the re-use of materials (the glass fibres are processed for final use as new raw material, such as wool for insulating purposes, short fibres for reinforcing casting compounds, plastic items, high strengthen concrete etc.).
http://www.refiber.com/technology.html

3) DNV KEMA

DNV KEMA conducted the project REACT (EU-funded), where recycling possibilities have been tested. Various thermal processing methods and material recycling options were considered. Two processing methods turned out to offer the best prospects. In the short term, thermal processing of the turbine blades in the cement industry will be possible. In the longer term, mechanical recycling is to be preferred. Within this project, research was done on:

- a new hybrid grinding technology
- recyclate reactivation for optimal mechanical properties
- separation of different materials in the waste fraction
- new applications for FRP recyclate

http://www.kema.com/services/consulting/pgr/hse/recycling/recycling-blades.aspx

4) Universities

There is also some on-going research in some universities. Please see below a contact from the Université Libre de Bruxelles who is working on a new way of recycling the wind turbine blades.

Source: EWEA – European Wind Energy Association www.ewea.org