Identify the technology that you'd like to propose.

a. What is it?

From the literature review, the technology that we would like to propose is **biomass technology: pyrolysis .**

b. Why do you choose this technology? Why not others?

We choose to propose **biomass technology: pyrolysis** because biomass is a promising eco-friendly alternative source of renewable energy in the context of current energy scenarios. Current global energy supply is to a large extent based on fossil fuels (oil, natural gas, coal), of which the reserves are finite. Given the growing world population, the increasing energy consumption per capita and the evidence of global warming, the necessity for long- term alternative energy sources is obvious. For these twin crises of fossil fuel depletion and environmental degradation, energy planning and technology improvement has become an important public agenda of most developing countries. Biomass can be converted to bio-oil via different thermal, biological and physical processes, hence we choose biomass (Brennand, 2004). Not only that, Brennand state that among the biomass to energy conversion processes, pyrolysis has showed that it has the ability to attract more interest in producing liquid fuel product because of its advantages in storage, transport and versatility in application such as combustion engines. In addition to that, solid biomass and waste are very difficult and costly to manage which also gives impetus to pyrolysis technology. Pyrolysis technology has the capability to produce bio- oil with high oil-to- feed ratios. Thus, pyrolysis has been receiving more attention as an efficient method in converting biomass into bio-oil during recent decades (Friends of the earth, 2002). The main reason why we propose this technology is because it produces few air emissions due to the limited use of oxygen. Hence, saving the earth from getting more pollution. The contamination of air emissions is easy to control because syngas is cleaned after production which is not found in the rest of the technology mentioned in the literature review. Pyrolysis technology produces useful products for multiple applications too (Jimison, 2004). Most importantly, pyrolysis plants are flexible and easy to operate as they are modular. They are made up of small units which can be added to or taken away when the mass or volume of organic matter changes.

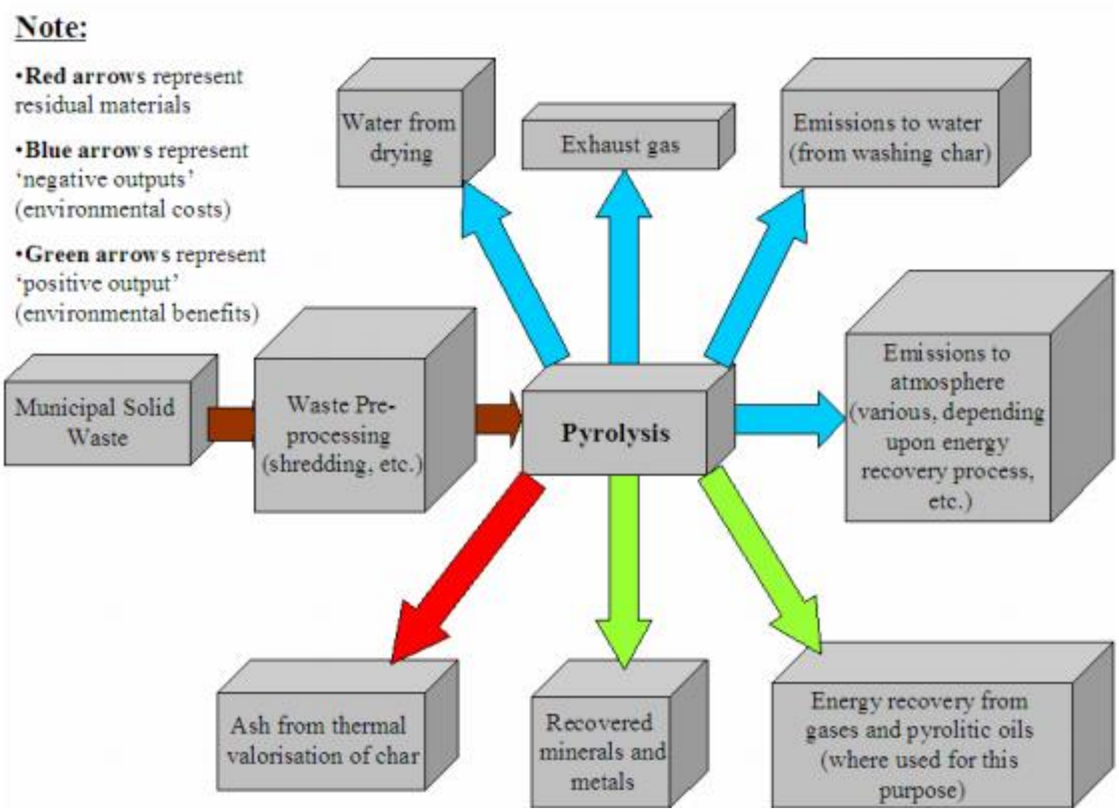

Diagram 1: Schematic diagram of the inputs and outputs of the pyrolysis process (Eunomia Research and Consulting, n.d.)

c. Is it a sustainable technology? (balanced between economy, social and environment).

1. Potential contribution to sustainable development

- ***Global sustainable energy supply***

The combustion of bio-oil in gas turbine lead to cogeneration of heat and electric power may become a preferred and efficient option to harness the energy potential of solid biomass once technologies have reached commercial maturity. Technologies like Biomass Integrated Combined Cycle or Biomass Integrated Fuel Cell promise higher electric conversion efficiencies (more than 40%) than the direct combustion of biomass (between 10 and 40%), which is the conventional technology.

- ***Climate change mitigation***

In combination with sustainable forestry and agricultural practices, the application of biomass pyrolysis for power generation can be regarded as a carbon neutral option to substitute or avoid power generation from fossil fuels.

- ***Fuel Applications of Bio-oils***

Over the last two decades there has been a growing interest in using biomass-derived fuels. Initially this interest was driven by concerns for potential shortages of crude oil, but in recent years the ecological advantages of biomass fuels have become an even more important factor. Biomass fuels can be considered essentially CO_2 neutral and have a very low sulfur content compared to many fossil fuels (Czernik & Bridgwater, n.d.). In addition, being a liquid, bio-oil can be easily transported and stored.

2. Environmental Issues

Greenhouse gas emissions from the operation of plants that integrate biomass pyrolysis and electricity generation are climate neutral. Other types of emissions related to the operation of the plants may become an issue and require proper management.

- ***Emissions from gas cleaning***

The cleaning of producer gas is also a source of emissions. The main objective of the clean-up process is the removal of components that prevent the gas from being used further, e.g. tar, particles and acid compounds (H_2S, NH_3, CO_2). Depending on the cleaning process used, contaminated wastewater, sludge and solid residues may represent a significant environmental hazard and need to be treated properly (Lettner et al., 2007).

- ***Emissions from gas combustion***

Emissions from gas combustion depend heavily on the quality of the producer gas. Compared with power generation from fossil fuels, lower concentrations of carbon dioxide (CO_2), sulphur oxides and nitrogen oxides can be achieved. Exhaust gases also tend to have higher concentrations of CO than is the case with fossil fuels. This is because of the relative higher content of carbon monoxide (CO) in the producer gas. Conventional technologies for clean-up exhaust gases can be used to meet local emission standards.

3. Social Issues

The introduction of biomass-based power technologies requires the establishment of reliable biomass supply chains. Under proper regional management schemes, the supply of biomass can support local development.

- ***Potential conflicts with social realities***

Some economic and social aspects may be affected when large increases in biomass production are necessary. These aspects include food security, land use and land ownership and agricultural and forestry development. The introduction of biomass gasification technologies to supply of electric power can therefore have a direct impact on social development at the local, regional or national level.

4. Economic Issues

The biodigester and the generation set constitute the main investment outlay in terms of generating electric power using bio-oil. The resulting power generation costs depend heavily on the source of substrates. Biomass from waste flows often has no market price. The costs of substrates are negligible in such cases and only the costs of collection and transport activities need to be taken into account. The situation with energy crops is entirely different, however. The variability of market prices has a strong impact on the financial feasibility of a project.

- ***Capital costs of small applications***

The Energy Sector Management Assistance Program has assessed the costs of a small 60 kW electric power system (Energy Sector Management Assistance Program, 2007). The capital costs for such a system are between USD 2,260 and USD 2,720 per kilowatt (cost in 2004). These figures are not expected to vary significantly in the future, as the main cost factors (biodigester and engine-generator set) are mature technologies with low cost reduction potentials.

d. Is there any catalyst involved? What type of catalyst? How much is required?

Yes, catalysts are involved in the process of biomass pyrolysis, which produces a mix of solid (char), condensable gas (bio-oil) and permanent gas (CO, CO_2, CH_4, H_2O). A catalyst increases the rate of a chemical reaction without consuming or changing itself during the reaction. It plays an important role and is widely applied in biomass pyrolysis processes. In general, catalysts are used to enhance pyrolysis reaction kinetics by cracking higher molecular weight compounds into lighter hydrocarbon products. This catalytic process is called **Fractional catalytic pyrolysis**, the rapid heating of biomass under inert atmosphere in the presence of a suitable catalyst to produce high quality bio-oil and other chemicals (French and Czernik, 2009). The catalysts used are known as the Y-Zeolite based Fluid Catalytic Cracking (FCC) catalysts. The fractional catalytic pyrolysis is conducted in a 50mm bench scale bubbling fluidised bed reactor. The operational variables controlled and investigated are the temperature (400-600^{o}C), weight hourly space velocity (WHSV = Mass Flow Rate/Catalyst Mass) and vapour residence time (total volume of fluidised catalyst divided by gas flow rate at reactor conditions). Mante, Agblevor and McClung (2012) stated that nitrogen is used as the fluidising gas in this process and the flow rate was controlled by a flow meter. During the catalytic pyrolysis, the mixture of char, entrained catalyst, gases and vapours that leave the reactor were separated by a hot gas filter maintained at 380^{o}C. As for the amount of catalysts required, this is the ratio of biomass feed and catalysts used. The biomass is fed continuously for an hour at a rate of 100-300g per hour from a feed hopper into a 100g fluidised Y-Zeolite based FCC catalysts. Moreover, most of those were used only at a small scale to improve gas production for research purposes.

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