Energy group 1

1.0 Introduction

In Lobitos and Piedritas there is electricity outages weekly and this causes large economic and welfare problems as vaccines have to be kept refrigerated. So as a group we have decided to come up with a solution to these electricity outages to create a back up electricity source. We are going to come up with an energy source that will sustain 1700 people's energy requirements during the outages and also to provide a clean renewable energy source to the people to try make them less dependent on fossil fuels. The solution will have to be affordable as the residents of Lobitos and Piedritas have very low incomes as 30% of Lobitos population live in poverty and in Piedritas the amount of people living in poverty is 70-80% of the population. The solution should also be easily maintained to so its easy for the locals to use without having to work on it too much.

2.0 Decision process

2.1 Focus areas:

We came up with many different solutions that we thought would be possible, that fits our specification. These energy sources included Nuclear energy, biomass energy, tidal energy, microbial fuel cells and solar energy. We came up with a criteria that would help us make our mind up on what energy source to use.

2.2 Alternative options considered:

We considered nuclear energy as it is a very clean energy as it doesn't produce CO2 also it is very efficient as In comparison to other fuel methods, 1kg of U-235 produces 24,000,000 kWh of power. Nuclear power is also extremely reliable and when controlled, can be turned off and on at need. Although nuclear power is a bit too unrealistic for Lobitos and Piedritas as a Nuclear powerplant can cost between $6 Bn and $9Bn to set up alone, and then they would need engineers and skilled workers to work in the plant and to maintain it, which would be very difficult to source as there is a lack of availability of engineering expertise.

We considered biomass as Biomass energy is a renewable energy which is converted from plants and animals. It is produced by burning these organic waste materials to produce heat. Biomass energy is becoming an increasingly popular choice for providing an alternative fuel source to traditional gas and coal solutions. Once the waste is burned it can be converted into clean products such as steam, biodiesel and biofuels. It can also be converted into gasses such as ethanol and methane and electricity. These products can then be used in either a residential, industrial, or agricultural setting. Biomass energy is environmentally friendly as it doesn't depend on fossil fuels as the towns waste can be burnt, this is especially helpful as Lobitos is a fishing town and with fish there is a lot of wasted energy, i.e. the head bones scales and organs. Although it isn't as efficient as other fuels it could cause deforestation if they locals get carried away and start chopping down trees. To get an idea, an automatically-fed pellet boiler costs between £10,000 - £19,000, including the boiler installation cost and delivery. While a smaller

domestic biomass boiler starts at £5,000; and an ordinary commercial installation aimed to heat two or more buildings can cost around £20,000. There are also various prices for different biomass types of fuel as well as other heating types. This isn't too expensive as it will pay itself off in the long run. This energy source is very helpful in their current situation with the power outages as it can be readily turned on to start producing electricity for the outages.

We also considered tidal energy as Lobitos is a seaside town so it would be a very obvious choice. Tidal energy is created using the movement of tides and oceans, where the intensity of the water from the rise and fall of tides is a form of kinetic energy. Tidal power surrounds gravitational hydropower, which uses the movement of water to push a turbine to generate electricity. This could be used in Piedritas and Lobitos to provide them with enough electricity to satisfy all of their energy needs, while being a long term and reliable option. The advantages are that the equipment can last a lot longer and be more cost competitive than other renewable technologies. It is also a green energy as it doesn't produce any greenhouse gases. Although it is expensive to construct tidal power plants and would take a lot of skilled workers, also there is a limited energy demand as powerful tides normally only happen around 10 hours a day and this means a storage capacity must be developed. The tidal power plant would also kill lots of fish which isn't good for the environment and for the locals as that's primarily their diet.

We also considered Microbial Fuel Cells they are Just like an ordinary battery, an MFC uses chemical energy to generate electricity. An MFC has two electrodes held in separate chambers. The anode chamber that contains the bacteria is anaerobic. This means that it does not contain oxygen. The cathode chamber is aerobic. The oxidation process occurs inside the bacteria living in the anode chamber. This takes advantage of the oxidation that bacteria carry out naturally during cellular respiration. Electron bonds hold together the molecules in the food that bacteria eat. The bacteria break those bonds to release the electrons. Pros of microbial fuel cells include its an alternative fuel source its Eco-friendly its Common In places lacking electricity. Recovery of valuable compounds from substrates. Efficient conversion of substrates to electricity. Cons of microbial fuel cells. Low growth rate of microbes. Toxicity of material. Low power output. Electrodes lack strength and durability. Fuel cells need replaced nearly every five years. They are made up of an expensive material (platinum). These are also relatively new and might not be very reliable.

We also considered solar energy as the towns are very sunny. Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. Solar energy is good as it would help the locals get free electricity and be able to sell unused electricity to the grid, it is a green energy so it would reduce their carbon footprint a lot. Although it doesn't work on every roof type, would mean the household wouldn't be able to move as the investment would take years to pay itself back. It would require local installers which would be hard to find as someone would have to train. The panels only need swiped down a few times a year which is very low maintenance.

2.3 Ideas considered:

To help us come up with a final solution we decided to make a criteria that would help us decide what would be best. As seen in table 1 we took cost, sustainability, maintenance environmental impacts, functionality and public opinion into consideration as we agreed that these were important factors to take into consideration.

Table 1 *Bad –1, Good-5

Criteria	**solar**	**biomass**	**nuclear**	**Tidal**	**Microbial fuel cells**
Cost	2	2	1	2	5
sustainability	3	3	3	5	1
maintenance	5	5	1	3	4
Environmental impacts	5	3	2	2	5
Functionality	5	4	2	5	4
Public opinion	5	4	1	2	5
Total	25	21	10	19	24

Solar did win the criteria points as seen in Table 1 although solar panels have already been provided to Lobitos so we decided we didn't want to go for them. Microbial fuel cells came second although these are only new technology and they aren't a long term solution. So we decided to go for Biomass fuel as we agreed it was the most realistic and long term solution.

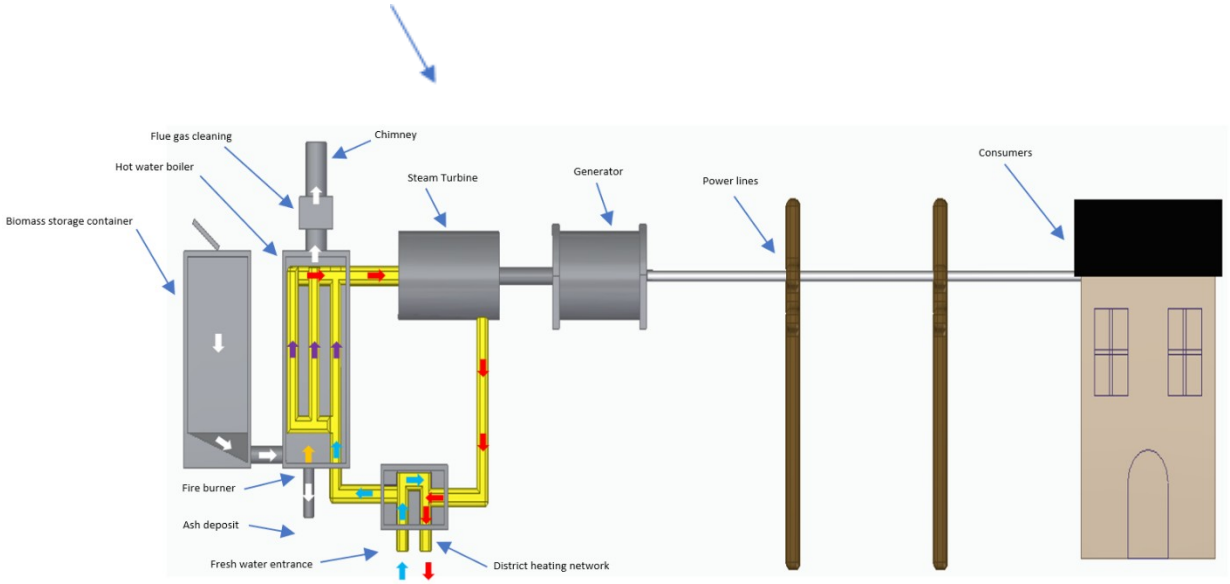
3.0 Final Design

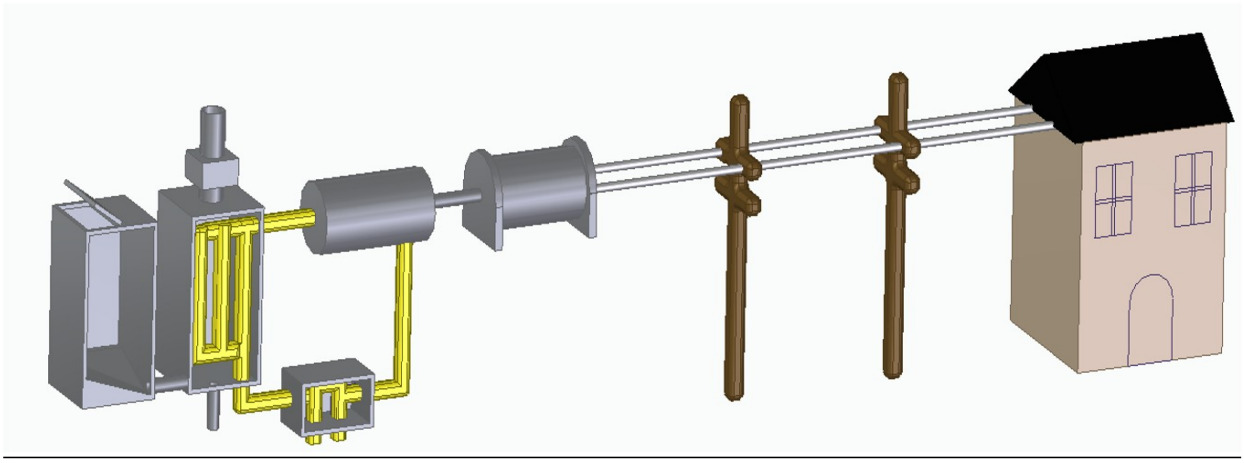
3.1 Final Idea:

For our final idea, we chose Biomass as our form of energy, due to it meeting our design specification while offering a different energy source to the ones that the people of Lobitos and Piedritas already have in use (Solar). Biomass is quite a pragmatic way to create sustainable energy in places where the residents are on low incomes as there are various objects that can be used as fuel, including the waste from each household as well as waste from businesses to be used e.g. the local fishermen, instead of discarding their leftovers from gutting the fish they can put these into the biomass storage container which can then be burned and used as fuel. In turn this could act as source of income as they could sell this waste to the company or government that owns the Biomass facility while simultaneously decreasing the amount of waste pile up in landfill and the streets, helping to keep these towns cleaner which is necessary especially in Lobitos to make the place look well as it gets tourists who come to surf. Also, most of the operations this Biomass energy facility completes are automated and therefore requires little human input therefore reducing the chance of human errors which leads to less maintenance needing done.

3.2 Final Design:

Figure 1: A schematic of the Final Design





3.3 How it works/Features:

Looking at Figure 1 you can see the Biomass storage container, the lid of it has sensors that make it open automatically and remain open until the machine has deposited the waste into the container and has removed its arm from the container, once the lid senses that the machine has withdrew it will automatically begin to close and seal tight. The sensor will react to only metal, this will ensure that the lid will not just open any time something comes near it e.g. if birds were to sit on the edge of it. This feature improves the machines safety as nothing unwanted can enter the storage container. This is necessary as fish remains and household waste will be inside the container which could attract scavenging animals e.g. birds.

Once the waste is deposited in the storage container it moves down the slope into and then through the tunnel at the bottom. The slope uses gravity to push the waste into the tunnel, meaning that no unnecessary mechanical parts are needed to pull the waste forward, decreasing the overall money spent on the machine through manufacture and maintenance costs.

The waste is pushed through the tunnel and once it comes out gets burned in the fire, in turn this creates heat which converts the water in the pipes above it into steam, which then rises to the top pipe and travels into the turbine, meanwhile the gases that are produced by burning the waste rise up to the top of the container where they escape through a pipe that leads into the filter, once the gases have been successfully filtered they exit the machine by traveling out the chimney and into the open. This is one of the reasons why we picked biomass for these towns, as the gases that are released may contain some harmful gases amongst them so they need to be kept far away from people, which is easily done in Lobitos and Piedritas as their populations are quite small (1300 in Lobitos & 400 in Piedritas) meaning there is a vast amount of vacant land far away from the towns, making it perfect for biomass energy facilities to safely operate.

Once the steam is produced it then travels into the turbine which then begins to turn, this leads to the kinetic energy being converted into electricity which then travels into the generator, across the power lines and into the electricity grid making it available for the consumers to use. After the steam powers the turbine it then goes down an insulated pipe underneath the turbine which leads the heat from the source to the district heating network which delivers it to a number of domestic and non-domestic buildings, e.g. to the houses in the towns or shops.

3.5 Justification of Design:

We chose our design as it is a cheap form of energy generation and would allow the Peruvians to convert a large range of biomass into useful electricity; This includes general waste and agricultural waste which could help clean up the towns too, converting the chemical energy from the rubbish into electricity. This is good for a low-income area as it cuts costs for running the biomass generator, making it more affordable for the town.

As fishing is a large industry in Lobitos and Piedritas excess or left-over fish could be sold to biomass plant to fuel electricity to the town and helps pay the fishermen for what otherwise might have gone to waste. If they need to produce electricity quickly, they can use wood or other natural materials growing around the town.

Biomass can be stored in the tank until when it is needed, this could help reduce the blackouts in the towns, as it could be turned on when electricity is low and helping the town save fuel when not needed, cutting down on costs. This also means that energy can be produced very quickly, and so if the electricity supply is under strain, it can be addressed very fast.

4.0 - Sustainability:

The sustainability of a biomass boiler and plant production is very high which makes it reliable. The boiler itself relays on numerous variables to keep it running and creating energy. The following information is referred to 4.1.

- Wood can be used in this production because it released carbon dioxide (C02) which can be converted into fuel when it is placed into the boiler. Therefore, with a biomass boiler it stores the carbon that is burned and converts it into energy.
- Agricultural waste is also used to make energy due to the carbon that is burned as well as the nitrogen.
- Animal waste is another common form of fuel that is used in the boiler because it converts fuel from the gases that are released when the waste is burned.
- Crops and other food production can also be used to be burned to create fuel this is because of the chemical energy stored in the food is converted into electrical and kinetic energy.

Due to the various different ways of fueling a biomass boiler makes it more sustainable than the other options that we looked at as a group because there is endless ways to keep the boiler running and creating energy. This is perfect for a rural country because it is necessities that is used to fuel the boiler.

A biomass boiler also is sustainable due to having the positive points that it doesn't pollute the area around it by releasing Sulphur or mercury gases which helps prevent acidic rain. It also helps with waste build up due to the boiler being able to use waste to create energy that they can then use in their homes as batteries and to help with transport. This information in this section of text can be referred to 4.2.

It is also sustainable because of the materials that are used in the making of the boiler which are mostly aluminum metal which is a long-lasting wear and tear material. The average life expectancy of a biomass boiler is 25 years without much maintenance or a lot of parts having to be replaced. However, there is very little to no maintenance except for cleaning that the locals would be taught how to clean and refurbish therefore making a job for them. The information in this section of text can be referred to 4.3.

5.0 Cost breakdown

[1] Table 2

Cost breakdown	Price	£ to Sol
Staff	A minimum of 6 staff are needed to run the biomass plant, the average salary for these workers is £6000 annually.	£6000 x 6 = 36,000 £36,000 = 184,282.56 Sol a year
Maintenance	A budget of £500,000 will be needed a year, for extra material, spare parts, specialists to fix it etc.	£500,000 = 2,559,480 Sol
Building power plant	A small power plant costs roughly between 3-4 million to set up, including material and contracting costs. For a large plant it is 12-13 million, in total.	*Small* £3- £4 mil = 15,356,880 – 20,475,840 Sol *Large* *£12 – £13 mil = 61,427,520* - 66,546,480 *Sol*

Total:	
	79528162.6 – 89766082.60 Sol

Withing the running of a biomass power plant, the three main categories of costs include the following; staff, maintenance and building of the power plant. As represented above in Table 2, the building of the power plant is the most expensive part. This is due to the cost of planning, materials and building supplies, cost of wages for builders and the cost of wide exposed land. To run a power plant there needs to be at least 6 members of staff available at all times. The role of each member of staff includes the daily operating, maintaining and generation of electricity. To become a qualified staff member, a lot of training is required as these are highly sophisticated tasks. The cost of training staff is included in the maintenance side of the cost breakdown, which also includes extra building supplies for breakdowns etc. After considering all of the above sub-costs, the end cost of running a power plant comes to at least 79528162.6 Sol, annually This is equivalent to £15,477,086.63.

6.0 Implementation Plans

Our plan for implementation is to have the biomass generator on-site of the town, and have access open to everyone, so that the whole population of the town can utilize it, and potentially make some extra income with its adoption. As the generator is much smaller than other forms of renewable energy, it could be set-up easily within the village limits, meaning that to get to it, they wouldn't need to travel far, which is essential for bringing rubbish or biomass to burn. The villagers could be trained to use the generator themselves, and so nobody would need to be hired to run it day to day. Someone within the town could be trained to maintain the generator too, providing a skilled job to the local area.

The town would be able to bring their waste to the generator and fill the tank with biomass, and when needed, the generator can be switched on to provide electricity to the towns, or to sell to the state. This gives the town access to the larger grid, and so if they need to raise money, they can burn off biomass and sell the energy produced, creating a new form of revenue for the towns.

To aid in blackouts, the generator can also be used as there will be biomass in the tank, so adjusting for the strain in supply can be done quickly and effectively. Fuels like biodiesel or bioethanol could be used in these circumstances in order to speed up the energy generation and get the towns electricity back on at a faster rate.

6.1 Opportunities Associated with Implementation

The Peruvian Government has aimed to make renewable energy 60% of its overall energy generation by 2025, up from 55% which it stands at now. Biomass makes up 1% of the total energy produced. This shows that there is room for growth for biomass and that the Peruvian government are eager to set-up more renewable energy sources. They have also created incentives for new renewable projects, which includes access to the transmission and distribution network, allowing for fast construction of the generator and any maintenance that needs done, and long-term stable tariffs. Renewable energy plants also get priority

for the dispatch of electricity and the government has guaranteed purchase of all energy produced. This is very beneficial for the towns of Lobitos and Piedritas, as if they have a surplus of fuel, burning it in the generator will create income for the towns and be very beneficial to the local economy.

Another advantage is that renewable projects are allowed accelerated depreciation of up to 20% on machinery, equipment and civil constructions, which lets them pay less tax in the earlier years after setting up, saving them money.

This shows that there is huge potential for renewables in Peru in the next few years, especially considering the governments incentives. It is a good time to utilize biomass and take advantage of the perks of building renewable in Peru.

7.0 Experiences gained

At the start of our project, we all got to know each other and broke the initial awkwardness. This really helped me as I felt more comfortable working with new people. Some members in the group have strong computer skills and explained programs, I have never used before and explained various aspects of programs that I have used. On top of this I feel that I have learned how to work better in a team online, as it is much easier in person. **- AJ**

Participating in this project was quite interesting, because we acquired a snapshot into how concepts for engineering projects are designed and brought forward whilst getting an in depth view into what the various stages are in the design of a product and how to complete them. - **JC**

Throughout this process I have learned valuable team working skills, through co-operating with members of my team and working together to split the workload amongst us. It has helped me be a better team-worker by giving me experience with working with other students and setting out to get specific goals done against a deadline. This has also developed my communication skills through discussing and developing ideas and planning the project. This project has also developed my researching skills, by making me look online for information to suit the project's needs. - **TA**

Through-out this task I have benefitted and been able to develop my team working skills by seeing different views on one specific task and then being able to come together as a team for one solution through compromise and good delegation of individual jobs. I personally feel like the criteria table helped us all a lot because everyone had their part and they were able to talk about what method we would've used to solve the problem in Lobitos and Piedritas. By doing this project I feel like it has developed my communication skills by being able to talk about which points I feel are valid and being able to talk about my perspective on the solution that we have collectively as a group came to. I also feel like this project has enhanced my outlook of third world countries and how much help they do need and what we could potentially provide them. - **E-L.L**

This group project was very beneficial for me as I was able to build on my teamwork skills and be able to see other people's views and I learnt how useful breaking tasks into teams can be. We were able to go and do our own research and share it with each other and also share all our opinions with each other which I thought was very beneficial. We were able to come up with solutions that would be economically,

environmentally and socially acceptable. I really enjoyed the group project and definitely grew confidence in my group work and communication skills.

- BC

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