The Wood Generators
Clean Electricity from Wood

Formal Project Report
E-Design 100 #22

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Summary

Arcelormittal is one of the largest steel manufactures, wooden pellets and lumbers are received from the delivery of incoming material this increases the waste footprint of Arcelormittal. Currently Arcelormittal follows cradle to grave method where it just throws the wooden pallets as waste and does not recycle them. This is increasing the waste footprint of Arcelormittal. This project further investigates different methods to reduce the amount of waste produced due to the wooden pallets. Our goal is to recycle 100% of this waste into useful energy or resources. The group came up with solutions which finds a way to convert the wooden pallets into electricity, making it efficient and economically for Arcelormittal.

Problem statement

Arcelormittal would like to reuse and/or recycle 100 percent of the wooden pallets and other lumber waste from incoming material delivery, to reduce its waste footprint.

Arcelormittal receives a lot of waste pallets and wooden lumber from the delivery of incoming material, as the pallets facilitate the movement of material by forklift. Currently Arcelormittal does not recycle the pallets and wooden lumber, some of it is given to employees to burn at home, the remaining is frequently discarded, which is causing significant amount of waste lumber to be generated. This is increasing the waste footprint of Arcelormittal.

This project will investigate different methods to reduce the amount of waste produced due to the wooden pallets. The solutions will include ways to reuse the wooden pallets efficiently and economically.

Sustainability

In general terms, sustainability is the endurance of systems and processes. We defined sustainability as a way of process where it doesn’t affect anyone or anything. In this world of limited resources it is of crucial importance that all these resources are used in a productive manner in any process.

Background

The group came up with multiple ideas some of which included:

1- Burning the wood to generate heat over the winter months
2- Chop the wood into small pieces and use it to generate electricity
3- Using a square drill to section out and remove the nails from the wood and then donating or selling the wood.

After constant discussion and google searches the group finally shortlisted the solution where we would first remove the nails using a nail puller we first remove the nails, the nail puller is a simple power drill attachment which is easy to use and doesn’t not require too much effort. As shown in figure 1 this is how it will work.

![Figure 1: Initial drawing of the nail puller idea](image)
After the wood is clean of all nails it can be chopped further to get small pieces of wood which can be put into an electrical generator which will be able to produce wood gas, from which it will produce electricity. This will be very helpfully for Arcelormittal as they will be able to produce clean and free electricity which can be either stored for later use of also can be used for the offices.

Using patent search we found the nail puller whose patent number is: US 8371556 BZ

Customer Needs:

After reviewing the information presented by Arcelormittal we chose the following customer needs:

1. Environmentally friendly procedure used
2. Easy to recycle/perform
3. Cost effective
4. As automated as possible
5. Sustainable
6. Safe
7. Conforms to Local Laws
8. Should be Profitable

Table 1: AHP Matrix

<table>
<thead>
<tr>
<th>Customer Needs</th>
<th>Environmental Friendly</th>
<th>Easy to Recycle</th>
<th>Cost Effective</th>
<th>Automated</th>
<th>Sustainable</th>
<th>Safe</th>
<th>Conforms to Laws</th>
<th>Profitable</th>
<th>Total</th>
<th>Weight</th>
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<td>.33</td>
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<td>1</td>
<td>9.1</td>
<td>.12</td>
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<td>1</td>
<td>1</td>
<td>.5</td>
<td>1</td>
<td>.33</td>
<td>.33</td>
<td>2</td>
<td>1</td>
<td>7.1</td>
<td>.09</td>
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<td>Cost Effective</td>
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<td>2</td>
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<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>14</td>
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<td>.33</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>.33</td>
<td>7.1</td>
<td>.09</td>
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<tr>
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<td>3</td>
<td>.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>12.5</td>
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<td>12</td>
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<tr>
<td>Conforms to laws</td>
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<td>1</td>
<td>.5</td>
<td>4.8</td>
<td>.06</td>
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<tr>
<td>Profitable</td>
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<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td>.14</td>
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</table>

Total: 77.6  1
Sustainability and Cost effectiveness were among our highest ranking needs because they are the main reason that Arcelormittal presented the issue in the first place. Safety and Profitability are both important because while recycling is great, the prospect of getting a return on investment is even better.

Concept Selection:

Our initial design concepts included building houses with the wooden pallets, burning the wood to generate electricity, removing the nails from the pallets using strong magnets, and chopping the wood into wood chips. After putting the designs through the design matrix it was decided that combining the second and fourth options would be the best course of action. Because burning the wood for fuel provides guaranteed energy and therefore guaranteed money it was the ranked highest, but chopping the wood pallets up is included in the process of burning them for fuel.

<table>
<thead>
<tr>
<th>Feature/Requirement (weight)</th>
<th>Easy to Recycle</th>
<th>Cost Effective</th>
<th>Sustainable</th>
<th>Safe</th>
<th>Profitable</th>
<th>Automated</th>
<th>Totals</th>
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<td>5</td>
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<td>5</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2.83</td>
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<td>2</td>
<td>1.5</td>
<td>3</td>
<td>1.5</td>
<td>1.63</td>
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</tbody>
</table>

While there is the side effect that our design produces carbon based waste it was the option most beneficial to the company. by provided another onsite energy source that they can use they reduce their reliance on outside energy sources. This also provides a means for them to recycle the nails in the pallets that were not able to be removed by the nail removal tool as they can be collected from the ash after burning. This process is very cost effective because the nail removal tool is inexpensive, and while the initial setup cost for the furnace might be large it would pay itself off relatively quickly. Because of what Arcelormittal does their employees are already equipped with heat resistant equipment so they are well prepared for the possible dangers of a furnace.

Design Review:

The design review brought to our attention that the waste products might be an issues, however through research we have been able to come up with ways to combat that problem. Also, the reviewers recommended that we find ways to make the process faster and require fewer workers which can be easily accomplished.
As we start with the wood pallets, either wood chips or nails will be obtained from them. The nails can be recycled in the steel recycling process, and the wood chips will be introduced to the wood gas system that will eventually produce electricity. Because the plants are usually in isolated areas this process
would not likely affect anyone nearby, and there are also not likely to be laws preventing the burning of wood on private property

**Solidworks/Physical Model**

![Figure 3: Process of removing the nail from the wood](image)

![Figure 4: Solidworks model](image)
The main revenue for the company is from making steel as they are a steel company. But as inputs there are many things required to be used such as the raw materials, labor, etc and through the process in the factory, they are able to produce steel. The outputs also include a lot of waste especially wooden waste, which our team tried to tackle. Our aim was to take these wooden pallets and convert them back to the electricity, which is used as an input for the company. Hence this will save money for the company, increase their profits and also help them to reduce their waste footprint.

**Cost and Feasibility Analysis:** The estimated cost of a stoker boiler, a form of a wood generator varies from 1880-4260 USD/kW\(^3\) and the LCOE range of these generators varies from 0.06-0.21 USD/kWh\(^3\). The payback time for such a generator is about 6 years\(^2\). This makes it very unfeasible compared to electricity production from fossil fuels. But ArcelorMittal does not face this problem. Only 20% of the LCOE range goes into operational costs and all ArcelorMittal have to worry about is that. The raw material for the electricity production is free for ArcelorMittal as it is just the waste wood. This will help ArcelorMittal get back its investment money in a much shorter time, thus, making the process feasible. As for the cordless drill nail puller, the price is $50 each\(^1\). ArcelorMittal can reduce its costs by employing existing workers into these technologies by paying them slightly extra wage. After the pulling the nails, ArcelorMittal can recycle them and use them in their own steel making process, this will lead to lower cost and higher profits. Similarly after the payback time, electricity costs decrease significantly for ArcelorMittal, which will also increase the profits. There is no cultural, security, legal or privacy issues in any of these processes. The processes, in fact, diverts trash from landfill and reduces costs for the company.

**Life Cycle Analysis:** The initial lifecycle of the wood and nail was largely linear. The wood would come into the industry bringing supplies. Then it would go out in the form of wood waste or sometimes employees would take them home. This is an extremely wasteful use of the wood. We made sure, all our decisions were based on the fact that we wish to convert this linear lifecycle into a cyclical one and we successfully did so. The wood comes into the industry in the form of boxes goes out as waste and
comes back again in as electrical energy to be used in the manufacturing process. The nail, similarly, goes out as waste and comes back in the industry as raw material.

**Conclusions:** In creating the system design we tried our best to come up with a solution that would be extremely effective and finally, we succeeded in our goal. Our design helps divert extremely huge amounts of waste from the landfills and also helps the company save money by reducing the cost. Furthermore, the production of electricity from wood is much more environment friendly than that from fossil fuels, thus helping ArcelorMittal to reduce its footprint. The extraction of nails also help ArcelorMittal to reduce its cost and waste. But with all these pros, our design has some minor cons too. The setup of the generator has a large initial cost and has a significantly long payback time. ArcelorMittal might also have to hire new workers and accommodate new space for the processes, this might also involve buying new property which will further increase the cost. But, these disadvantages are very minuscule when we compare it with the huge amounts of advantages this system design boasts.

**References:**

1) [http://shop.cordlessdrillnailpuller.com/](http://shop.cordlessdrillnailpuller.com/)
2) [https://energypedia.info/wiki/Electricity_Generation_from_Biogas](https://energypedia.info/wiki/Electricity_Generation_from_Biogas)
6) [http://thumbs.dreamstime.com/x/pile-nails-2870482.jpg](http://thumbs.dreamstime.com/x/pile-nails-2870482.jpg)