**Cover Page**

Collecting large amounts of solid waste materials such as food, paper, glass, plastic, and metal is a serious problem that occurs in over 63 countries around the globe, it is especially apparent in many developing countries such as Lebanon, The Philippines, and Nigeria. Solid waste substances can leach into surface water or groundwater which harms living organisms. Areas that contain lots of solid waste are usually unpleasant to live in because they can be infested with disease carrying insects. Moreover, these places contribute to an increase in serious illnesses. They are hazardous since they bring flies, rats, and various kinds of insects which can affect people’s health as they are associated with numerous diseases. Furthermore, they harm the environment as they bring strong and unpleasant odors. Therefore, one of the solutions that my co-workers and I investigated during our travel to some developing countries such as Lebanon is recycling. It is a highly technical process that is used in many developed countries to manage solid waste issues. My co-workers and I expect that if the recycling plan is implemented properly in our 5 chosen locations in Lebanon, by April 2014, it would result in reducing over 60 percent of the waste as well as saving millions of dollars.

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NSERC Undergraduate Student Research Awards Program

350 Albert Street  
Ottawa, ON  
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November 27, 2013

Dear Sirs,

I am writing to you regarding the funding of my research proposal entitled “Managing Solid Waste in Developing Countries”. The proposal intends to provide a solution for the growing solid waste problem that occurs in developing countries by implementing a recycling process. The proposal contributes to protecting the environment, reducing air and water pollution, and removing foul odors that occur in and around the landfills. Recycling protects the ecosystem and reduces the amount of waste that is being transported to landfills. I am currently studying for my bachelor in Civil Engineering and will be under the supervision of Dr. Lan Lin who has experience in the field of Building, Civil, & Environmental Engineering. I will attempt to implement the recycling program that is being used in developed countries and then take this project to the Lebanon and then expand it to other developing countries.

This research will not only allow me to enhance the productivity of the recycling process and lead to a more eco-friendly society, but it will also change people’s lives in the developing world. Hence, I am requesting the research grant of $25,000 for this project. The estimated time period for our research is from February 1st, 2014 to April 12th, 2014 (Approximately 10 weeks). This funding will be used to implement our recycling plan effectively in our 5 chosen locations in Lebanon.

Sincerely, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Table of Content**

**Literature Review…………………………………………………………………….……….4**

**Developing Countries’ Current Solid Waste Problem (Lebanon as a Sample)...................4**

**Proposed Solution, Methodology, and Materials....................................................................8**

**Justification and Conclusion.....................................................................................................9**

**Schedule.....................................................................................................................................10**

**Budget........................................................................................................................................11**

**Qualifications.............................................................................................................................12**

**Press Release..............................................................................................................................14**

**References..................................................................................................................................15**

**Literature Review**

The process of recycling was conducted in the United States (U.S.) in 1992 and resulted in reduction of the amount of [CO2](http://www.co2-chemistry.eu/media/files/press%20release/13-11-20PRCCUnova.pdf). This reduction of [CO2](http://www.co2-chemistry.eu/media/files/press%20release/13-11-20PRCCUnova.pdf) is equivalent to taking 33 million vehicles off the road which is accomplished by recycling up to 82 tons of materials [1]. Plants save millions of dollars by buying used and recycled products rather than purchasing new materials. Annually, 4 billion dollars is saved by the city of St. Louis in the United States. One of the major advantages of recycling is that it reduces the amount of garbage thrown into landfills. For instance, when there was a concerted effort to implement recycling program in the U.S., more than 60 million tons of garbage avoided being disposed of into landfills. In addition, recycling most of the solid wastes contribute to saving energy. For instance, recycling iron would definitely consume less energy than going through the whole process of mining, refining, and then making a whole new iron product. In addition, recycling saves the ecosystem and reduces the amount of waste transported into landfills. Transportation is a major contributor to the emission of environmentally harmful substances. Among these are carbon monoxide (CO), hydrocarbons, nitrogen oxides (NOx), carbon dioxide (CO2) and particulate matter [2].

**Developing Countries’ Current Solid Waste Problem (Lebanon as a Sample):**

In Lebanon, many people simply dispose of solid waste by throwing them in the garbage where they are collected by municipalities as solid waste. From there, most solid waste makes its way to landfills. Although it is possible to find a solution for the solid waste problem in Lebanon, it has not been done yet. The problem occurs when many municipalities do not accept solid waste to be submitted for recycling; as a result these recyclable materials end up in landfills. Some studies show that there are around 5 locations in Lebanon which suffer from the poor treatment of solid waste which leads to disposal of garbage into the sea and waterways. This problem is happening in the city of Sidon and Tyre and it began when the municipalities did not allow the surrounding villages to throw their waste into Sidon’s or Tyre’s landfills. When people were unable to dispose of waste into the landfills due to the landfill’s capacity having been reached, they instead were throwing their refuse into the sea [3].

Statistics show that there are roughly 4.5 million people living in Lebanon. In fact, many areas in Lebanon have huge amounts of solid waste that is not disposed of properly. For instance, approximately 60 percent of the waste is located in the city of Beirut, the capital of Lebanon [3]. The statistics show that there is 900 tons of generated waste found in Beirut, 300 tons of waste found in the southern areas of Lebanon, and 700 tons of waste generated in the north of the country. Even though there are large amounts of solid waste throughout various cities in Lebanon, only 8 percent of the waste was recycled in 2011. The solid waste that is thrown into the streets and into the sea includes different types of garbage such as organic, plastic, glass and metal trashes. Solid waste is a serious problem in Lebanon since it has caused a lot of issues such as polluting the atmosphere. Since there is no organization or domestic company responsible for treating the waste with advanced technologies and methods, in many cases garbage is being burnt which has resulted in air pollution [4].

Most of the solid wastes are composed of a combination of nickel, iron, copper and sometimes even lead. Each of these four metals pose various and notable health impacts.

**Nickel**

Although nickel is not harmful when exposure is limited, high concentrations of solid waste which contains nickel can pose a definite danger. When people dispose of nickel in the sea or in the street, it can enter the body through either the food or water people consume. According to Global Healing Center, tests conducted on lab rats revealed that high amounts of nickel cause damage to the circulatory system, liver, stomach, kidney, and immune system. While these results were obtained from tests on rats, they provide a general framework for the effects on humans. In addition, high concentrations of nickel have been found to cause asthma like reactions in humans, poor lung function, certain forms of cancer, and organ damage. In addition, approximately 10-20% of the population has heightened sensitivity to nickel; these people are more affected by nickel poisoning than normal [5, 6].

**Iron**

Iron is a very abundant and essential metal. However like nickel, iron is toxic in high concentrations. Specifically, iron is a basic requirement for the survival of bacteria, parasites, and cancer cells. It also increases the mortality rate from infectious diseases. Iron is also involved in degenerative diseases such as Parkinson’s, Alzheimer, and the aging process of skin [7].

**Copper**

Copper is found in many places including pipes and bottles, it can be found as an alloy or in its natural state. If they remain in the streets for an extended period, they can be decomposed into small particles and can become airborne. These airborne particles that people can inhale are pathogens which can cause severe health impacts. After extended exposure, it causes irritation to the nose, mouth and eyes, other symptoms include stomach aches, dizziness, vomiting and diarrhea. However, higher levels of systemic exposure can result in liver and kidney damage, poor growth, impaired development, anemia and in extreme cases death [8].

**Lead**

Lead sometimes appears as one of the elements in many solid wastes. Unlike nickel and iron, lead is toxic even at low concentrations. Even small doses of lead can lead to effects such as headaches, lethargy, nausea, and abdominal pain. Higher concentrations have more severe health impacts such as brain damage, mental retardation, behaviour problems, anemia, cancer, and in extreme cases death. If lead is left untreated, it can result in impairment of normal growing development in children [9, 10].

**Solid waste causes climate change**

Solid waste is one of the fundamental causes of global warming. Different types of solid wastes such as papers, foods, and plastics contain methane gas and [CO2](http://www.co2-chemistry.eu/media/files/press%20release/13-11-20PRCCUnova.pdf) **which are emitted into th**e air after they are decomposed due to the waste being untreated in the landfills. Methane and [CO2](http://www.co2-chemistry.eu/media/files/press%20release/13-11-20PRCCUnova.pdf) **are the** main greenhouse gases that cause climate change.

The impacts of climate change are far reaching and not restricted solely to human welfare. Indeed, it is important to note that different domains, such as ecosystems and human welfare, are deeply interconnected as human standards of living are related to commodities only existing because of the presence of certain animals and plants.

One of the most severe impacts of climate change are rising sea levels, the increasing severity of storms, droughts, floods, the destruction of habitats, wildlife, vegetation and the change in the global landscape. The loss of biodiversity caused by climate change is of a particular concern to human welfare. Indeed, the location that humans choose to live in is heavily influenced on the services that surrounding ecosystems provide. With the disappearance of plant and animal species, our quality of life will also diminish [11].

**Proposed Solutions**

**Recycling (Solution’s Methodology & Materials)**

One of the solutions that my co-workers and I investigated during our travel to some developing countries such as Lebanon is recycling. This process is in limited use even though it is simple and can result in many advantages that contribute to protecting the environment, reducing air and water pollution, and removing strong smells that occur in the landfill areas. In order for the recycling process to be done properly, it has to begin with separating the various materials. All solid wastes need to be separated into their types such as paper, metal, and plastics and then need to be recycled in an appropriate manner. In general, the way recycling works for most of the materials is simple. When solid waste first arrives at the recycling plant, they get separated and then transformed into their fundamental states until they become raw materials. The recycling process aims to transform materials into their fundamental states so that we can make new products [12].

Discussing paper recycling process would be notable and worth discussion in this section since many of the solid waste materials consist of papers. After papers are collected in the bin, they are sent to the recycling plant which washes the paper with soap and water to remove all ink and glue. Next, different types of papers can be made such as printer paper, cardboard, and newspaper. When they are dry, they are cut and shaped for different purposes and then sent to shops [13, 14].

**Recycling Waste into Energy (Methodology and Materials)**

After wastes are collected in the landfills, they are taken by trucks to the recycling plant boilers. Within 2 hours, the waste is reduced to only 10 percent of its original volume. The water in the tubes is heated until they turned into steam. The steam powers the generator that enables it to produce electricity, which is sent to the fabric filter. It is a sophisticated fabric bag filter which captures any remaining particles that is released from the combustion of the metal. Turning waste into energy produces renewable and clean energy as well as reduces the emissions of the greenhouse gases. Therefore, this process is significant in that it provides multiple ecological and economic benefits [15, 16, 17].

**Recycling Waste into Fuel (Methodology and Materials)**

After solid waste is taken by trucks from landfills to the recycling plants, they are kept warm for several days. When solid waste is put inside big tanks called methane digesters, microscopic bacteria, which live inside the tanks, feed on the solid materials and create methane. The gas rises to the top of the tank and is collected into the pipes which take it to the purifying process where it is made into clean methane by removing impurities. Finally, the methane which is turned into fuel can be used to run turbines and then generate huge amount of electricity [18, 19].

**Conclusion & Justification** I request funding for this proposal because this project contributes to protecting the environment, reducing air and water pollution, and reducing the amount of garbage thrown into landfills, which leads to saving the eco-system and reducing the amount of products that are being transported into landfills. As a result of funding this proposal, millions of dollars will be saved and huge amount of emissions will be reduced. Moreover, through recycling we can produce large amounts of electricity by running turbines which can provide power to thousands of homes. Furthermore, recycling can turn waste into fuel and into renewable and clean energy which run plants and different kind of transportations.

**Schedule**

|  |  |
| --- | --- |
| **Week 1** | Meeting with co-workers to set the complete plan and decide the budget needed to suitably complete the proposal |
| **Week 2** | Prepare secured and covered vehicles that transfer loads to recycling plant |
| **Week 3** | Using the vehicles to collecting wastes such as plastic, iron, papers, and bags from 5 landfill areas in Lebanon |
| **Week 4** | Setting up section in the plant that stores wastes (papers and bags, plastics, and irons) separately |
| **Week 5** | Setting2boilers which reduce the solid waste volume until getting the solid waste’s fundamental substances |
| **Week 6** | Making 1 digester (big tank that completes the purifying process to remove impurities from gases that arise during boiling process) |
| **Week 7** | Setting up section in the plant to transfer fundamentals substances into fuel and energy |
| **Week 8** | Making pipes and steam generator that enable plant to use fuel and energy to produce electricity |
| **Week 9** | Collecting data about the work that has been done within 8 weeks and improving the recycling process |
| **Week 10** | Cleaning the raw materials and then cutting them and sending them to the shops |

**Budget**

|  |  |  |
| --- | --- | --- |
| **Item** | **Quantity** | **Cost** |
| Vehicles that Collect wastes | 5 | $1,500 |
| Workers (people who will implement the proposal in 10 weeks) | 10 | $15,000 (1,500 for each) |
| Section in the plant to transfer waste into energy and fuel | 1 | $2,000 |
| Plant boilers | 2 | $1,500 |
| Steam generator | 1 | $1,000 |
| Pipes | 20 | $2,000 |
| Digester | 1 | $2,000 |
| **Total** | **...........** | $25,000 |

**Qualifications**

Dr. Lin studied at Concordia University in the department of Building, Civil and Environmental Engineering. After that, she studies her master and PhD degrees at the University of Ottawa. After she finished writing her PhD thesis, she was nominated for the Governor General’s Gold Medal award. She wrote up to 40 technical publications. Apart from her academic experience, she has many experiences in design and building of bridges. Dr. Lin was honored with many awards such as NSERC postdoctoral fellowship, and Visiting Researcher fellowship at Stanford University. She has over 5 journal publications, 15 conference proceedings, and 20 research reports. One of Dr. Lin`s journal publication:

Lin, L.,Naumoski, N., Saatcioglu, M., Foo, S, and Edmund Booth. (2011). Selection of seismic excitations for nonlinear analysis of reinforced concrete frame buildings. Canadian Journal of Civil Engineering, File No. 2011-0189 (submitted).

One of her conference proceedings:

Lin, L.,Naumoski, N., Foo, S., and Saatcioglu, M. (2011). Assessment of the vulnerability of buildings to progressive collapse due to blast loads. Canadian Society for Civil Engineering Annual Conference, Ottawa, June 14-17, 2011

One of her research reports:

Lin, L.,Adams, J. (2010). Strong motion records of the Val-des-Bois, Quebec, earthquake of June 23, 2010. Online technical report, Geological Survey of Canada, 20 p. Available at: http://earthquakescanada.nrcan.gc.ca/recent\_eq/2010/20100623.1741/index-eng.php

The achievements of Dr. Lin are numerous, for this reason I strongly believe that she is the perfect fit for my project’s supervision. Her exceptional expertise in environmental engineering is what led me to choose her as my supervisor.

My name is Ossama Sabsoob and I graduated from a college in Syria in pure and applied sciences. In one of the classes that I took over there, I was part of a team that had to come up with the use of current tools and materials, ways to manage the municipal solid waste that was throughout our area. I have always been motivated in waste management. Furthermore, I have decided to study my major in Civil Engineering at Concordia University. I started my education in fall 2011 and I am expected to graduate by fall 2016. In the following semester (Winter 2014), I will be joining an association called **CSCE** (Concordia Society for Civil Engineering). It will promote my understanding of how to see things more professionally and more practical world. Since I have an interest as well as some basic knowledge and experience in field of waste management, I am proud to say there is going to be an excitement in working on this proposal.

**Press Release**

How can some people in the developing world live for 50 or 60 years when they are always surrounded by trash and garbage? How much better would they feel when they see everything around them is clean and there is no trash or garbage on the ground for extended period? Living in a clean environment where there is no solid waste thrown on the ground would first enhance the welfare of the human being. It will also help to offer many jobs as it contributes to opening new firms and plants which will hire people to work. In addition, it enhances the economy since it saves millions of dollars by avoiding the need to bring vehicles to transfer solid waste to landfills. How would people, especially in the developed countries react when they know that the solid waste becomes part of some human’s lives in many areas of the developing world? Leaving solid waste untreated will bring many different kinds of insects and will spread at least 22 diseases. Therefore, this proposal is the best solution for this problem. It will get rid of solid wastes and manage them properly by utilizing a very professional plan and workers. It is true that it will cost $25,000, however, it will result in many different returns such as saving the ecosystem and enhancing the economy.

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