

Added value and reducing environmental impact from landfill diverted waste streams

- *Master project description* -

Background

From 2017 to 2020, the greater Reykjavík municipal waste company SORPA bs. is sponsoring research into the processing of waste at the Álfsnes waste management site, in partnership with the environmental engineering company ReSource International ehf. (RSI). Currently, mixed household waste is landfilled, but there is a moratorium on landfill organic waste due to come into force in 2020. Thus, a biogas and compost plant is being built to receive 20.000 tons of organic waste annually, along with various means of removing contaminants such as plastic. This will also allow for better utilization of waste streams, with increased biogas production, a new generation of compost production, production of other useful organic compounds such as biodiesel or fertilizer and a relatively pure inorganic fraction with many possibilities for recycling or useful diversion.

Research program

In this program, two MSc students will work each year on two research streams.

1. The first stream will examine biogas production optimization techniques for the plant through pretreatment of organic waste and design of recirculation systems using Iceland's unique access to hot water resources. This research stream will also involve the building and operation of semi-scale model of the plant, along with participating in the design and construction of backup digesters to facilitate risk management.
2. The second stream of work will focus on the processing of non-organic waste streams that are separated from organic and household waste streams, comprising largely of mixed plastics. Currently this waste stream is exported for incineration at considerable expense, but there are possibilities to use it more productively, for instance to improve road construction materials and to create various kinds of synthetic fuel.

Each MSc will be a 60 ECTS thesis project, i.e. 1500 to 1800 hours – the equivalent of ten months of full time work. A 30 ECTS thesis or similar may be considered, but this must be clearly stated. Close supervision will be given by the R&D Managers of SORPA and RSI, as well as an academic in the relevant field. Due to the intensive nature of the projects, **SORPA will provide a stipend of 300.000 ISK per month to each student, and for some projects there may be the possibility of temporary housing at SORPA's Álfsnes site near Reykjavík.** Students will also have the opportunity to work at RSI's offices in Kópavogur.

It is expected that each student should submit at least one academic journal article in English to Waste Management & Research or a similar journal before their thesis is submitted. The thesis may be written in Icelandic or English.

The deadline for 2017 is the 8th of September. Interviews will be on September 11th and 12th and confirmation will be given on the 13th.

Application Process

To apply, send a **CV** (including academic transcripts or a course list with grades) with an **application letter** (max. 500 words) to jamie@resource.is.

Clearly include:

- Which project is chosen or preferred and why
- When you are available to begin
- A self-evaluation of strong and weak research skills
- Long-term academic and professional plans and interests
- Contact details
- If you wish to have housing in Álfsnes, Iceland
- Two academic references

Organic stream - Year 1

Mass and energy balance of a scale model biogas plant

This project will center around the design and testing of a semi-scale model of Álfsnes biogas and compost plant. It will be run in co-operation with Aikan, the designers of the plant, and the focus will be on the adaption of their design to Icelandic conditions, particularly the availability of hot water for heating, pretreatment and accelerated composting. This project will include opportunities to travel to Aikan's facilities in Denmark.

The Aikan process involves leaching organic compounds from organic waste and using this percolate to generate biogas. The rest of the waste is then composted aerobically. There are many methods of pretreatment to enhance initial hydrolysis of organic waste, and it is also possible to run the process at higher temperatures (e.g. 55°C).

Currently, there is a scale-model percolator and buffer-tank setup available for experiments. The student choosing this project will complete the system with an anaerobic digester, heat exchanger and recirculation system. It will then be used to simulate different conditions of the Aikan process.

The student will also make standards for simulating predicted homogenisation and contents of incoming waste streams. They will run several simulated process runs (2-3 weeks) at mesophilic and thermophilic temperatures to determine the mass and energy balance of the process under varying conditions. Lastly, they will run the system with landfill leachate as a percolation fluid.

Successful applicants will come from an engineering or laboratory background. Knowledge of microbiology and organic chemistry would be helpful. The project will require considerable amounts of handwork to set up and run the system – applicants must be comfortable with processing waste. Demonstrated skill at mechanical problem-solving or handwork is also a plus for this project.



Figure 1 - Percolator and two buffer tanks currently set up

Inorganic stream - Year 1

The use of mixed waste plastic to enhance the properties of hot-mix asphalt

This project will test the practical feasibility of using mixed waste plastic fractions in road laying in Iceland, following on from RSI's promising 2017 Vegagerðin-funded literature review and economic feasibility study. More than 5000km of waste-plastic-enhanced hot-mix asphalt is laid every year in India, and numerous studies have shown that it has significant potential to improve basic strength and resilience properties of asphalt and to increase the lifespan of road significantly. A thousand tonnes or more of plastic might be sequestered annually in Iceland's roads, and cost savings from reduced bitumen, avoided incineration and improved lifespan of roads may range from hundreds of millions to billions of ISK.

This project will involve designing and installing a plastic shredding system at SORPA's receiving center in Gufunes and running basic hot-mix asphalt quality tests such as Marshall stability, flow, void, Prall, wheel-track, skid resistance, abrasion resistance etc in an asphalt lab. The tests will be on hot mix asphalt modified with mixed waste plastic, of a composition based on an assessment of fractions available to SORPA. A particular focus will be on ensuring the environmental safety of any new mixture. If the experiments are successful, there will likely be a chance to participate in the laying of a test section of road.

Applicants should be studying an engineering or materials science degree or should have experience in running lab testing and working with the scientific method. No background in road materials science is necessary, but students will be expected to gain knowledge of the asphalt paving literature as part of their project.