Closed Loop Coast project seeks ambitious and curious students for a noble cause

Master Thesis

Remote Monitoring System for Closed-loop Food and Energy Production

(1 or 2 persons)

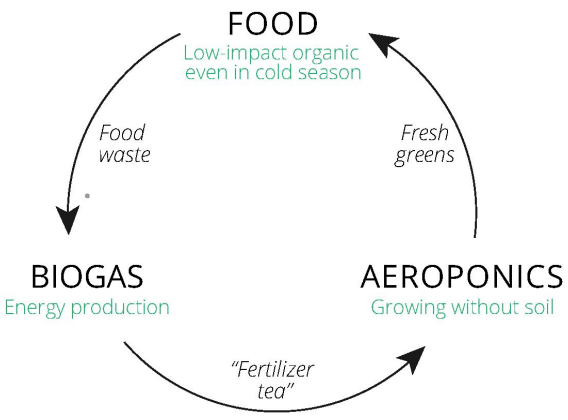
Be part of a unique cleantech experiment on Gotland

The Host of the project

RELEARN Suderbyn is a Swedish NGO for experiential learning and action research based at Suderbyn Permaculture Ecovillage on the Swedish island of Gotland. The NGO runs numerous international and national projects related to learning-by-doing on resilience, eco-lifestyle and non-violence. Our outreach work strives to link together driven persons to important ongoing work for sustainable development, serving people and the planet.

The Project

Closed Loop Coast (CLC): All-year Circular Food and Energy Production Systems for Sensitive Areas. It aims to design a model of an innovative climate-friendly circular system of food and energy production. The optimised model will be developed through testing of a functioning prototype on Gotland based on a set of eco-technologies, including biogas production, soil-free horticulture and geodesic dome shell. The innovation is in reusing the nutrient flow from biogas digester in aeroponic food production and returning plant-filtered liquid back to the biogas inflow. This allows to circulate the nutrients for the system's operation and therefore to reduce their inflow into the Sea. The dome shell expands the growing season and provides conditions for the system to function all year round with minimal carbon impact.



RELEARN Suderbyn has constructed the geodesic dome shell: 14 m diameter and 7 m tall greenhouse, in which the system will be tested as a functioning model of cradle-to-cradle design. Along with the closed loop system and the dome shell, its monitoring mechanism is to be developed and installed.

Open positions

One or two persons are invited to work on this project, thus your skillset might need to cover every aspect of the work or half the aspects.

Work aspects and required skills

The thesis falls mainly into the areas of embedded systems and human-computer interaction, but it also involves supervisory control and data acquisition (SCADA), internet and network technologies, electrical engineering, programming, database engineering and APIs, web-design and graphic design. Technologies and languages you would likely need to know (or learn): JavaScript, Modbus TCP, TCP/IP, Node.js, d3.js, three.js, Mongo DB, Raspberry PI. Beyond that, you need to be good in research and writing.

Compensation: scholarship and on-site housing and food options

Being a non-profit organisation RELEARN is interested in students enthusiastic about the closed loop idea and sustainability in broader sense, not in people choosing the subject due to available scholarship. We are looking for people passionate about closed loop systems and experimental innovations.

The symbolic scholarship is 5000 SEK per thesis paid upon completion of a thesis which practically assists the development of the CLC monitoring system. During the practical visits to the site for working with the prototype, the students will stay in Suderbyn Ecovillage which is the same location as the prototype. Food and accommodation will be offered for free. Accommodation options are to be discussed in the interview.

Your tasks

Collect the data from sensors (temperature, humidity, gas pressure, CO2, CH4 concentration, power generation, etc), process the data on the field level and send it to the online database. Build the required middleware: databases and APIs. Build a website that would fetch the data from the database and present it in a user-friendly way. Implement solutions for the alarms, trends and the basic supervisory control.

Note that our greenhouse needs to be completely off-grid and wireless. That means energy needs to be harvested and stored on-site, and the uplink connection would be through 3G/4G router.

Expected result of the thesis project

A working system that delivers the functionality outlined above, is stable, maintainable and documented.

Project workload

The workload of the project is 30 university credits, which is roughly 1200 hours of work

Project timeline in draft

January: Conduct a research on grid-independent field automation and monitoring systems for greenhouses. Outcome: a clear understanding how such systems are built.

February: Propose several competing architecture solutions, analyze their pros and cons, converge to one architecture. Outcome: a draft architecture of the monitoring system, with plan B for every part. Architecture implies an array of choices about hardware, software, networks, programming languages and technologies involved, and a drawing on how it all comes along together.

March: Iterate and improve that one architecture, validate it by building simple prototypes of fragments of the system. Finalize the list of the required components that we should order. Outcome: the validated system architecture and prototypes proving that it works.

April: Start writing the report in outline. Build middleware and user interface. Test the hardware as it arrives. Outcome: the piecewise working system which does what it should, a finalized report outline.

May: Install the hardware and get it connected, finalize the middleware and user interface. Write a thesis report. Outcome: the fully working system. Most of the report is written.

June: Finalize the report and the documentation. Outcome: the completed project and the thesis report.

Work Supervision

Instructor: Robert Hall
The Board member of NGO RELEARN and Suderbyn Permaculture Ecovillage, the technical director of the CLC project.
M.Sc. in Environmental Engineering and Sustainable Infrastructure (KTH Sweden)
Email: robert@gen-europe.org

Advisor: Angie Skazka
Visualisation developer at Gapminder foundation.
M.Eng. in Industrial Automation and Control Systems, M.Sc. in Human-Computer Interaction and Design, M.Sc. in Innovation and Entrepreneurship (KTH Sweden, Aalto Finland)
Email: konzeptmeister@gmail.com

Language

Thesis report can be in English, Swedish, Russian, Spanish or German (these are the languages we speak). The project documentation has to be in English.

Application

Send your application to: info@suderbyn.se, alco cc Angie konzeptmeister@gmail.com
Enclose your CV, the motivation letter (0.5-1 page) and your answers to test tasks.

Test tasks:

1. Calculate the battery capacity required to sustain 24 hours of power for five i/o units P8641, a Raspberry PI 2 and a 4G router of your choice. Is there an affordable battery of this kind we can buy?

2. Suggest a way to deliver alarms (value is up by 80% of critical level, battery is down to 10%, etc) to the people on the farm and outside. Some have smartphones, some don't.

3. The database size is limited to 500 MB and the measurements are coming from 50 sources (type float) every second. How to avoid the eventual overflow? How to use the space wisely?

4. Sketch a web user interface screen that displays currently/recently measured data and involves a visual metaphor of a greenhouse. The measured data is: 10 temperature points, 5 humidity points, 2 CO2 concentration points, 1 CH4 concentration point, 1 battery status, 1 solar radiation, 1 ambient temperature, 1 ambient humidity. All points are placed in different parts and heights of the dome, some are outside. Provide one picture of size 1024x768 pixels. Assume what's not given.

Additional Information

The Closed Loop Coast long-term objectives and partnership

Relearn Suderbyn has built partnership with Finnish natural resource institute (Luke); the partners has applied for Interreg Central Baltic Funding programme and are waiting for the final decision. This partnership allows to develop a sustainable model by running and testing the existing prototype of the Swedish partner as a pilot for the project, while utilizing knowledge and analytical resources of the Finnish institute. Whether Interreg funding will be approved or not, the project and testing is to be implemented.

The final designed system targets to rural households of the Baltic Sea archipelago and islands area in order to develop the remote areas and provide business opportunities for local residents. The output of the project will be a designed interactive manual allowing households and SME to create their own systems. The closed loop model, as an inspiring rural innovation suitable for sensitive rural coastal areas, will be promoted as an investment-ready design for the Baltic archipelago and islands, and also can be replicated in other regions with similar challenges.