Clim-ATIC

Northern Periphery Programme 2007-2013

Case Studies

Biogas Production

Sustainable Energy

BIOGAS

Location

Uummannaq &
Sisimiut,
Western Greenland.

Type of Adaptation

Research-led, anticipatory, capacity building project addressing energy production and security in peripheral communities in Greenland.

Research - Led Adaptation

Summary

Initiated by ARTEK/ DTU, this research-led project set out to explore the potential for using by-catch and fish processing waste for energy production in Uummannaq county. Initial findings favoured biogas over bio-oil production and, from 2008-2010, samples were tested to see which provided the necessary lipids and proteins needed for biogas production.

What is biogas?

Biogas is a renewable biofuel, typically produced by the anaerobic digestion and fermentation of organic matter, including: manure, sewage sludge, municipal solid waste, biodegradable waste.

- Acid-forming anaerobic bacteria break the material down into a simple organic liquid.
- Methane-forming bacteria digest the liquid effluent, creating methane (CH_4), carbon dioxide (CO_2), and a low-odour, nutrient-rich liquid as by-products of digestion.
- The gas products can then be tapped and used as biogas.
- The waste matter is treated for possible contaminants and usually spread as fertilizer.

Ideally, the gas should have a high-methane content (50%+) with a high calorific value. If refined effectively it is a valuable energy source that can be used directly to produce both power and heat and thus supply a community's needs for electricity production, space-heating, water-heating and process-heating.

The need to adapt

Most Greenlandic communities consist of small remote settlements dependent on oil for their energy needs. Rising energy costs and vulnerability of supply has spurred interest in renewable options. Biogas could potentially be the ideal means to treat organic waste, supply local energy needs and ensure the sustainability and survival of peripheral communities in a changing Arctic.

Key Words

Sustainable Energy
Sustainable Development
Biofuel Research

Stakeholders

ARTEK & DTU Researchers,
Communities of Uummannaq & Sisimiut,
Local Fishermen.

Sectors

Energy
Fisheries
Research

RESEARCH

By-catch and fish waste were mixed with household wastewater and macro-algae to create a fish mince biomass used in the biogas test plants.

Marianne Willemoes Jørgensen Ph.D student, Department of Environmental Engineering, DTU.

Consultation & Sampling

Methods

Consultation: A consultation took place between ARTEK, community leaders and fishermen in Uummannaq in the Summer of 2007. The focus was on the potential to use organic waste, including by-products from the fish industry, to supply the necessary lipids and proteins for the biogas process.

Sampling: Between 2008-2010 samples of shark, halibut and shrimp were shipped to the Technical University of Denmark for testing as well as 10 kg of frozen and 3 kg of live algae.

Results

Final results of the research will be written up in the Ph.D thesis of Marianne Willemoes Jørgensen, due in November 2011

Demonstration Pilot Plant

Outputs

Small-scale, portable demonstration plant in Uummannaq, with parts constructed, tested and documented at ARTEK.

Scientific publications and ongoing training to include the results of this project. See end of case-study for further details

Series of publications and short reports from ARTEK/ DTU

Future

- A demonstration pilot plant will be set up in the ARTEK Innovation Centre in Sisimiut, for capacity building purposes.
- There will be further research and development of biogas potential in South Greenland where warming has enabled agriculture to expand and increase suitable biomass.
- There will be ongoing optimisation of biogas production techniques by ARTEK students.
- There will be continued expertise exchange between ARTEK/DTU, Greenlandic communities and international partners.

Barriers & Constraints

Loss of Key Personnel: Key contacts in Uummannaq have been lost. This is in part due to the transient nature of the Danish workforce in Greenland, and also due to the reorganisation of municipalities in 2009 resulting in Uummannaq being incorporated into Qaasuitsup municipality, with administrative control passing to Ilulissat. Loss of these contacts has put a strain on the future siting of the pilot biogas plant.

Remoteness and Isolation: The project has been managed by ARTEK/DTU, with most work taking place in Copenhagen. While the Uummannaq community were consulted in 2007, limited communication, since, has created a social as well as physical distance from the project, which could inhibit community take up of the biogas units once they are available for domestic use.

Stakeholder Ownership

Strengths

Enduring Set-backs: While the main contacts for the project within Uummannaq are no longer there, the project has maintained momentum as overall control and financing was in the hands of ARTEK/DTU.

Expanding Options: The profile of ARTEK/ DTU in Greenland, coupled with extensive networking has raised interest in using biogas in the expanding farming communities to the south of Greenland.

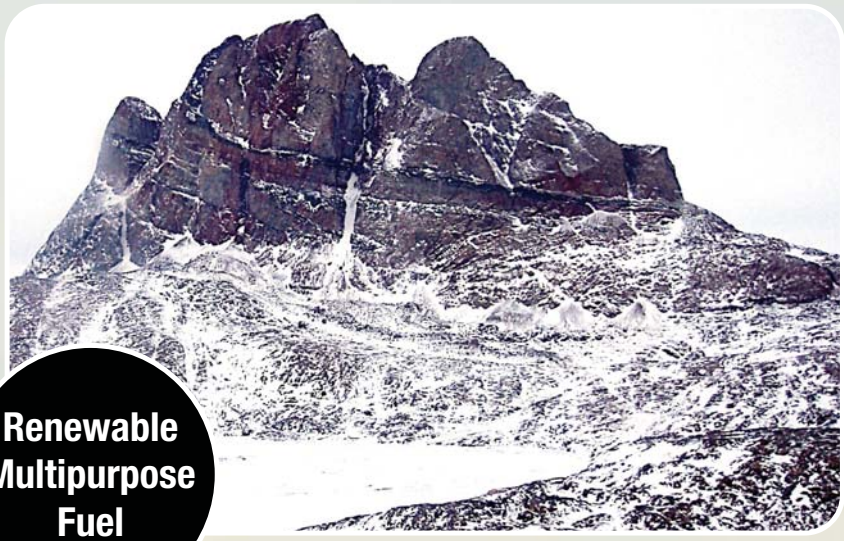
Key Lessons and Experiences

- Potential biogas resources do exist in Greenland.
- Greenlandic industries and communities are interested in biogas facilities, but they need support.
- While the project has maintained momentum under ARTEK/ DTU, limited communication and large physical distances have restricted community involvement and thus ownership.
- In response, a small-scale demonstration biogas plant is being developed for education and capacity building purposes in Greenland.

ANALYSIS

Biogas from the anearobic digestion of fish waste could supply 19% of Uummannaq's energy needs. This could be further enhanced through co-digestion: combining the fish waste with other substrates, such as seaweed, to achieve the optimum amount of methane.

Marianne Willemoes Jørgensen Ph.D student, Department of Environmental Engineering, DTU.



FINAL EVALUATION

Renewable Multipurpose Fuel

Advantages and Limitations of Biogas in a Changing Arctic

This demonstration project has set out to explore the potential of biogas to treat organic waste and supply local energy needs. The findings of this research will feed directly into pilot biogas projects and, hopefully, will contribute to the sustainability and survival of peripheral communities in a changing Arctic. Any community considering installing a biogas system should consider the advantages and disadvantages of such a system.

Advantages of biogas as a fuel

- High calorific value.
- Clean and economical to produce.
- Renewable, multi-purpose fuel.
- No residue produced.
- No smoke produced.
- Non polluting.
- Can be supplied through pipe lines.
- Burns readily.

Advantages of biogas plants

- Reduces dependance on fossil fuels
- Provides nutrient rich fertilizer
- Controls water pollution by decomposing sewage, waste and human excreta.
- Reduces landfill sites.

Limitations of biogas plants

- Initial cost of installation can be high.
- Sufficient and appropriate sources of organic matter are needed to feed a biogas plant.
- The raw material must be in a temperature range of 40°F and 212°F to ensure sufficient microbial activity to generate the biogas.
- Ensuring there is sufficient insulation of the raw material during the winter needs consideration for operations within the Arctic.
- Extra time is required for produce in comparison to other energy resources. This ‘time lag’ needs to be factored in.

Renewable Multipurpose Fuel

Questions to Ask Before Undertaking a Biogas Project

- Is biogas the best technological solution for your needs?
- Can a permanent supply of bio-degradable material be guaranteed at low cost?
- Will seasonality of supply increase the energy vulnerability of the end uses?
- Under arid conditions can sufficient water be secured?
- Under cold conditions can the raw material be kept at an optimum temperature for bio-digestion?
- Can financing of the biogas system be realistically solved?
- Does the number of potential biogas users in the community justify a ‘biogas project’ or the setting up of a ‘biogas business’?

People, Organisations, Publications & Links

Further Information

People

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Organisations

DTU Environment Technical University of Denmark www.env.dtu.dk
ARTEK Arctic Technology Centre, Sisimiut, Greenland www.artek.byg.dtu.dk/English.aspx

Publications and Reports

From ARTEK/ DTU

Biogas Production from the waste of the shrimp manufacture (English)
Biogas as energy source palvig (English)
PPT Biogas project,report Rovaniemi Feb. 2010 (English)
DTU Avisen no. 2, 2009 pdf. (Danish)

Further links

From the wider EU.

http://www.thecrownestate.co.uk/marine_biomass_anaerobic_biogas.pdf
http://www.aebiom.org/IMG/pdf/Brochure_BiogasRoadmap_WEB.pdf
http://www.european-biogas.eu/eba/
http://www.biogasmax.co.uk/
http://ec.europa.eu/research/infocentre/article_en.cfm?item=Result%20of%20search&id=/research/headlines/news/article_10_09_13_en.html&artid=17853

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FURTHER NOTE

Fisheries Management

Greenland shark

Initially this project focused on the utilisation of fish - processing waste from the halibut fishery and by-catch in the form of the Greenland shark (Somniosus microcephalus) which currently has no commercial value in Greenland. Both the by-catch and processing waste were found to have high lipid and protein contents suitable for biogas production.

The Greenland shark is viewed as a 'pest' in the local fisheries due to damage caused to fishing gear and perceived predation of commercial species. However using the shark for biogas purposes created a media debate concerning sustainability and impacts on biodiversity.

Need for a Management Plan

Current models and methods for analysing the economic and ecological effects of biofuel expansion focus on terrestrial habitats and terrestrial crops. At present, there is no impact survey available with regards utilising any Arctic marine species as biofuel. Without a proper management plan in place there is the potential for the Greenland shark to be turned from by-catch into a directed fishery with unknown effects on the marine ecosystem.

As little is known of the Greenland shark, it cannot be predicted what level of mortality from the fishery it can withstand and it is much harder to change fishing practices once fisheries have become established.

In light of this, and given the economic dependence of Greenland on its marine resources, there is a strong incentive to find alternative sources of biomass that aren't dependent on wild fish-stocks.

Algae

Finding a suitable source of carbohydrates within the Arctic has also proven to be a difficult task. Carbohydrates are critical for the biogas process, without them, micro-organisms would be unable to generate s stable and efficient supply of methane (Willemoes, 2010).

As part, of this biogas project algae have been researched as a potential source of carbohydrates. Tests were carried out on *Ulvaria Fusca*, a common algae in arctic regions and readily found off the coast of Uummannaq. Results, thus far, indicate that it would be a good source of easily accessible carbohydrates.

However, the *Ulvaria Fusca* algae are used by the Greenland halibut to lay their eggs in (Willemoes, 2010). Halibut represent one of the largest fisheries in Greenland at present. Harvesting algae directly from the ocean could have critical consequences for the halibut population and thereby the halibut industry. Due to this, testing is currently being carried out to see if degassed biomass can be used as a fertilizer in controlled algae ponds (Willemoes, 2010). Meanwhile, the ongoing quest for other sources of carbohydrates and proteins in the Arctic continues.