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# Biogas Production From Shrimp By-products In Sisimiut, Greenland.

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# Fish industry is dominant

**Greenland's economy based on fishing**

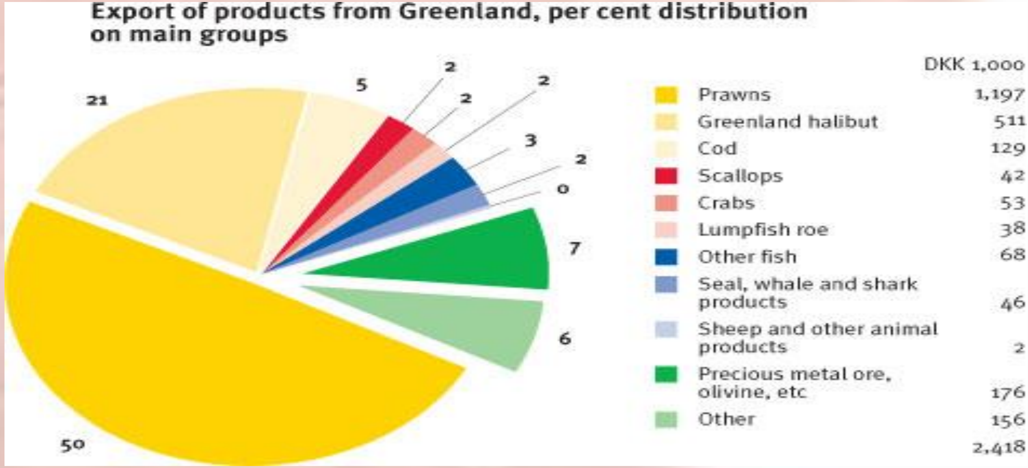
90% of its exports

**Shrimp and crab waste**

32.000 ton dry matter/year - 5.500 ton is processed to shrimp flour

**Fish waste**

46.000 tons/year - il was in a period extracted from 3000 ton of the halibut waste for energy recovery.



# Present challenges

- Major part disposed off at sea
- Contains organic matter
- > 20m deep disposal by Sisimiut
- Oxygen depletion at seafloor – dead seabed
- Emission of methane from anaerobic biodegradation – climate impact
- General waste challenges:
  - Organic household waste
  - Sludge from wastewater treatment
  - Bag toilet and septic tank content

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**Can we make the anaerobic digestion happen under controlled conditions, collect biogas and utilize the energy?**

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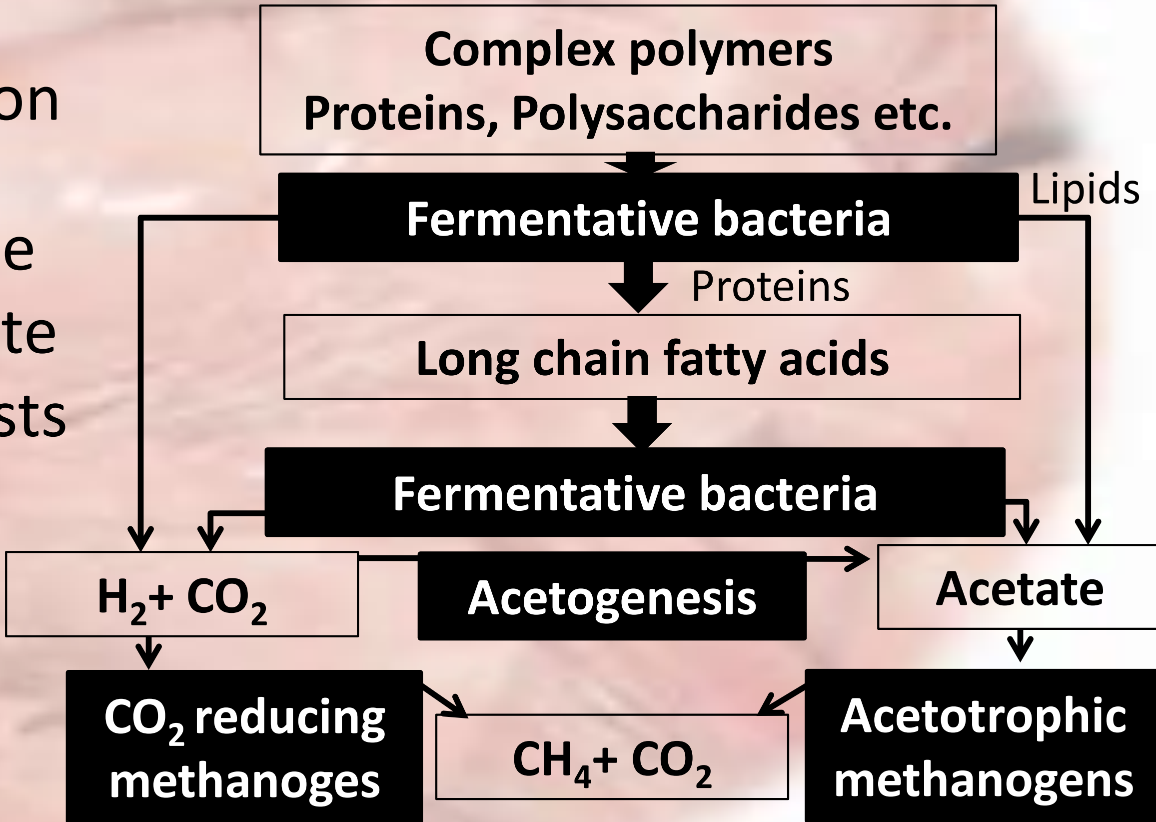
# Envisioned challenges

- Shrimps: Protein → Ammonia → Inhibition
- Halibut: Lipids → Inhibition of methane
- Cold, changing climate
- Lack of local specialists
- Seasonal shift in loading material and rate

**Simplified overview of anaerobic digestion process**



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# Biogas plants


Can be very simple installation or highly industrialized optimized plant.

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# Biogas plants


Keep it simple!

Can be very simple … n or highly industriali… zed plant.

# Biogas use

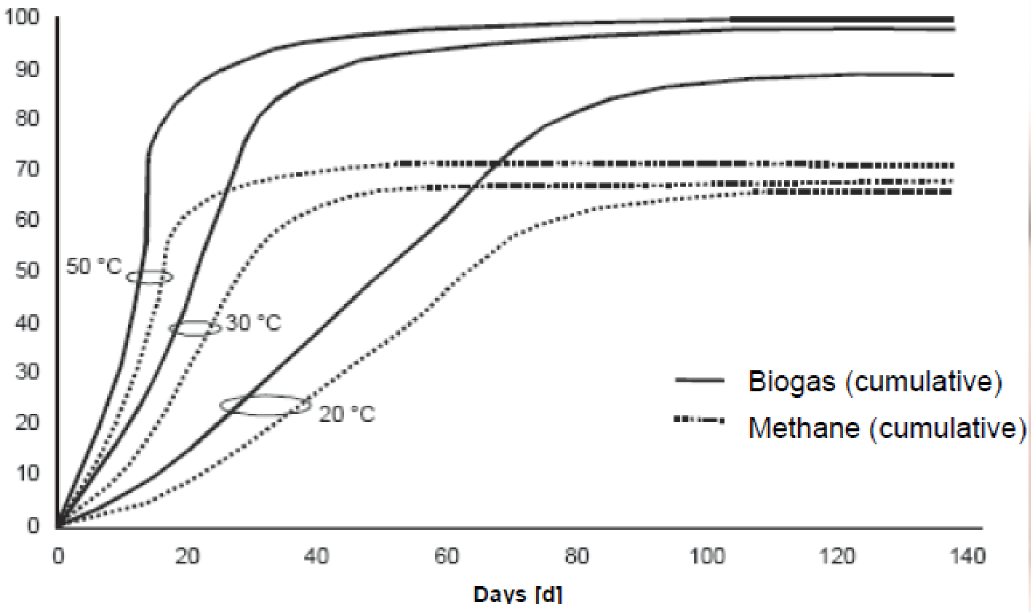
- Electricity – requires large scale plant + energy conversion
- Vehicles – biogas from vegetable products, requires upgrading of gas
- Heat or cooking – can be used directly

  - Simple technology for use of gas to e.g. heat water for boiling of shrimps or heating of buildings

# Temperature

**Low temperatures**
Slower – higher retention time – larger tank

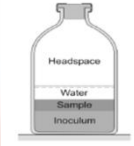
**Lower risk of inhibition and instability at mesophilic conditions**



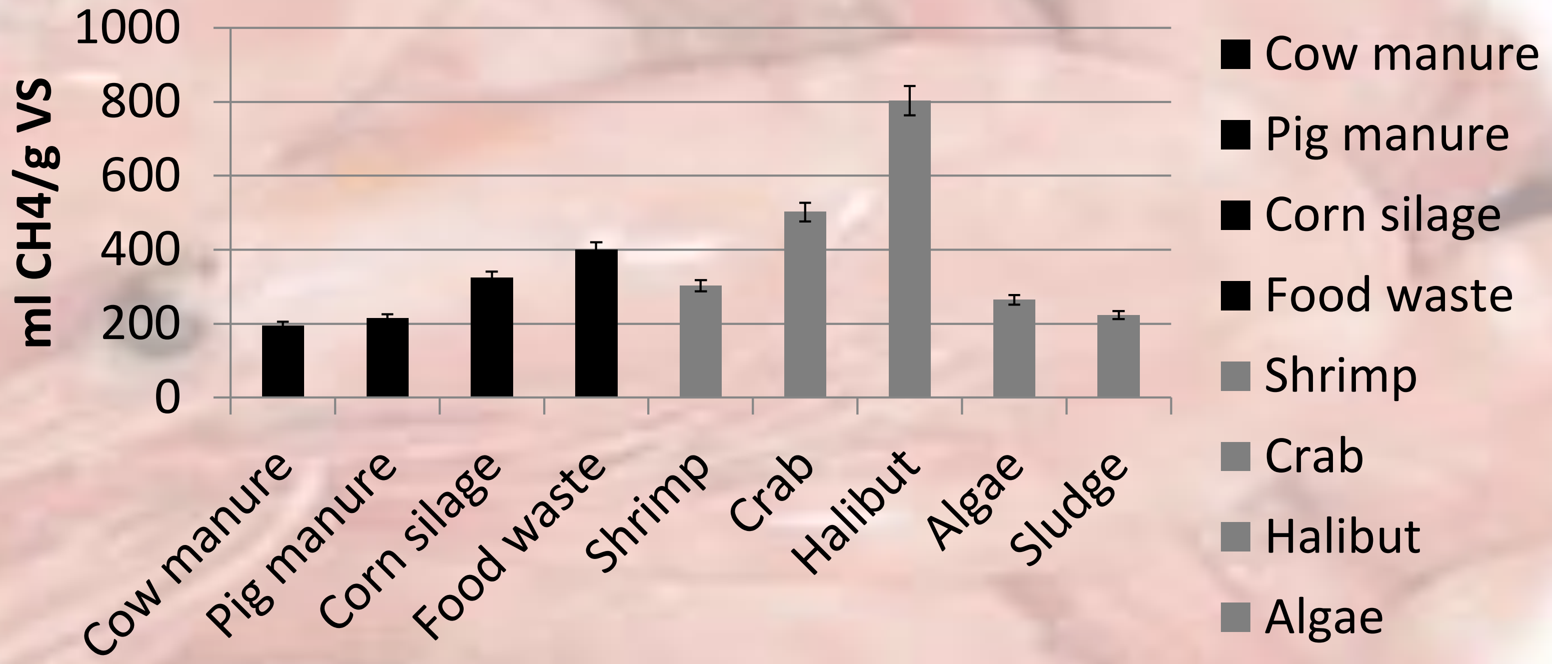

| Thermal stage | Process temperatures | Retention time |
|---|---|---|
| **Psychrophilic** | < 20ºC | 70 – 80 days |
| **Mesophilic** | 30 – 42 ºC | 30 – 40 days |
| **Thermophilic** | 43 – 55 ºC | 15 – 20 days |

# Mixture

- Starch and sugars needed!
  - Food waste
  - Algae



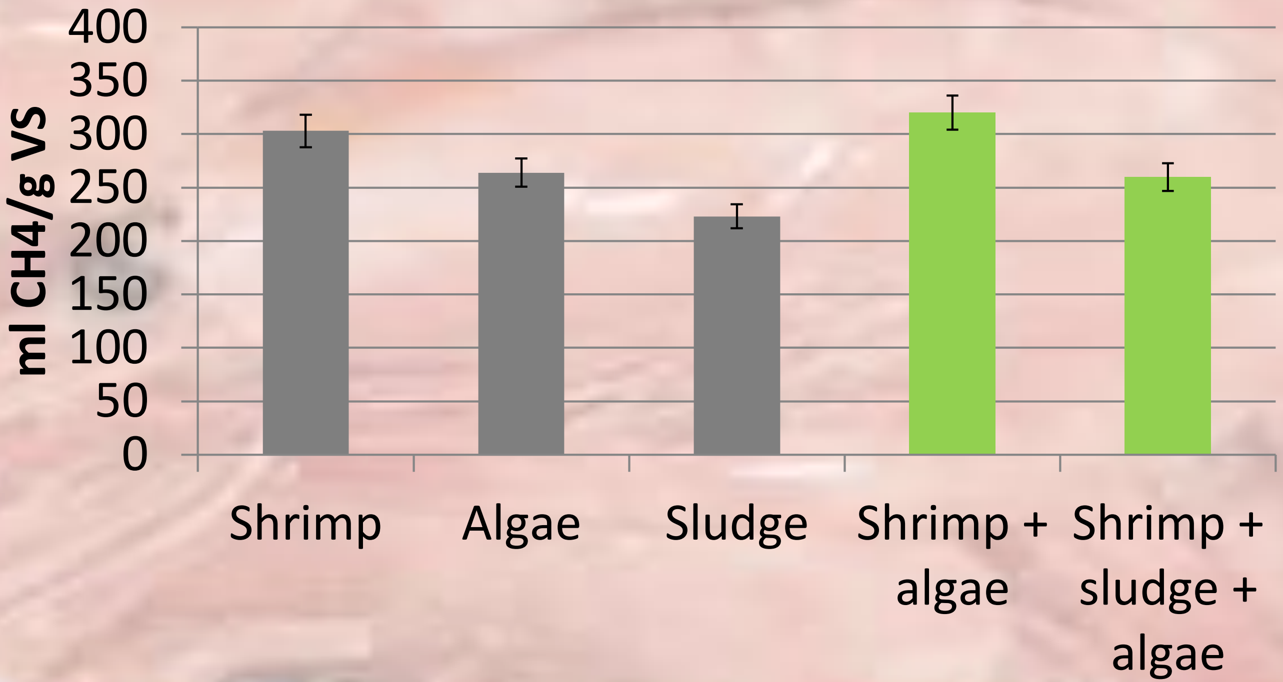

# Methane potential




Literature values, thermophilic

Our measurements, mesophilic


# Methane potential



# Potential

**In Sisimiut**

Potential reduction of heating with biogas: ≈ 1,000 $m^3$ diesel/year

Present consumption by shrimp processing facility: 1,300 $m^3$ diesel/year

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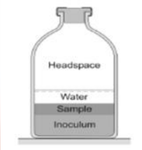
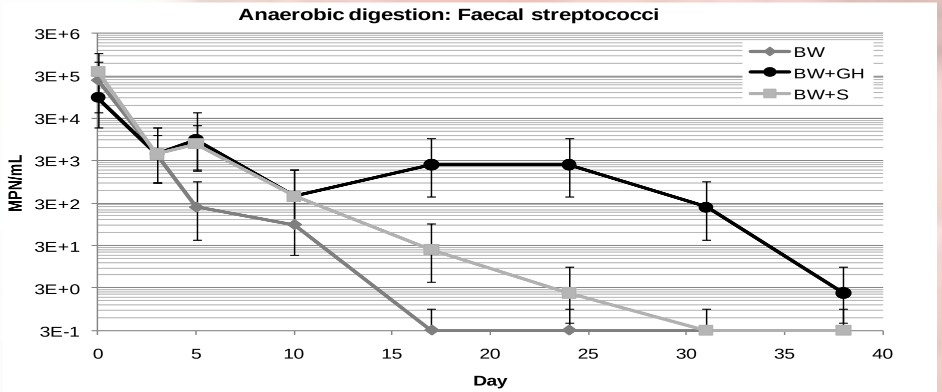
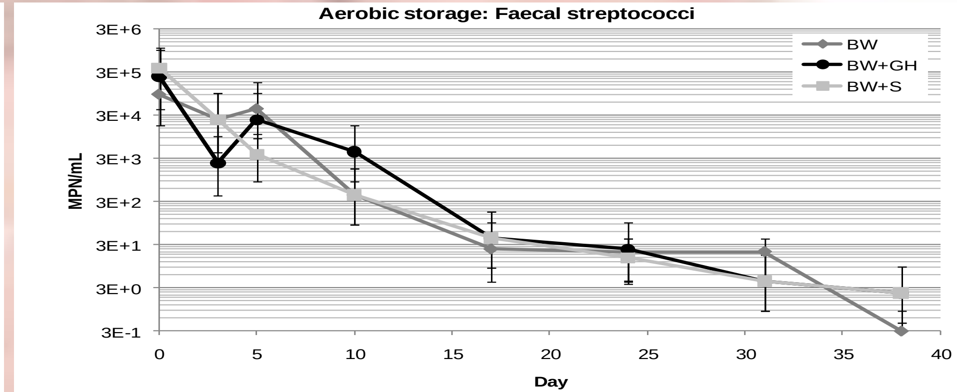
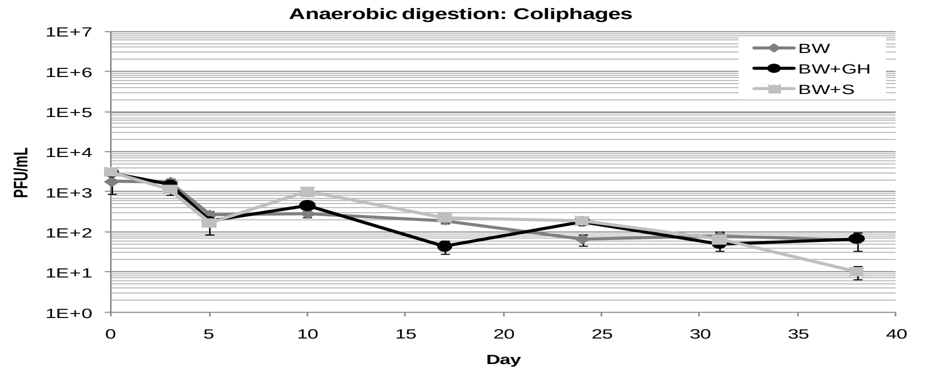
# Hygienization of blackwater

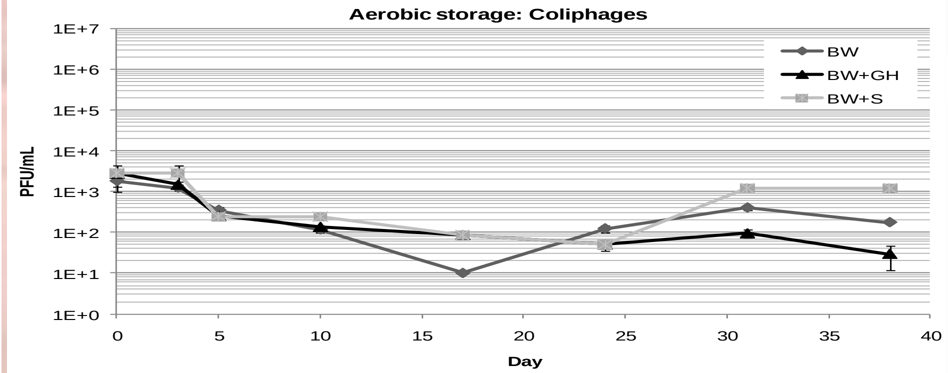



## Incubation at 37°C




Gunnarsdóttir, R.; Heiske, S.; Jensen, P.E.; Schmidt, J.E.; Villumsen, A; Jenssen, P.D. Effect of anaerobiosis on indigenous microorganisms in blackwater with fish offal as co-substrate, *Water Research*, 63, 1-9, 2014.

# Other options

- Shrimp flour
  - Local experience
  - Low price
  - Only shrimp residuals
- Bio oil
  - Only halibut
- Chitin
  - Advanced processing
- Food for fish farming?
- Other ideas?

# Conclusions and outlook

- Fish and seafood by-product do have significant biogas potential
- Risk of instability of process due to high lipid and protein content, change in temperature, seasonal variations in loading, lacking of local experts.
- Mesophilic conditions may help stabilize process + reduce need of heating/insulation
- Mixing with organic food waste, sludge and/or algae may help stabilize process + solve mutual waste challenges – needs to be investigated.
- Knowledge exists for operation, but innovation is needed prior to successful implementation in circumpolar area + other cold areas

# Team

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