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AQUAREL

AQUATIC RESOURCES FOR
GREEN ENERGY REALIZATION

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Fish waste utilization in Republic of
Karelia – Potential and environmental
impact



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Content



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- Fish waste utilization
 - Biodiesel production, anaerobic digestion, fish meal
- Sewage sludge and manure
 - Anaerobic digestion
- Environmental impact of fish waste utilization
 - Fish meal production vs biodiesel production





Fish waste properties

| Fish | Fish part | Moisture | Lipid/fat | Protein | Ash | Reference |
|-------------|----------------------------|-----------------|-----------------|----------------|----------------|-------------------------|
| | | wt-% | wt-% | wt-% | wt-% | |
| Pink salmon | Liver | 77 | 3.3 | 19 | 1.5 | Bechtel & Oliveira 2006 |
| Trout | Head | 70 ± 2.8 | 12 ± 0.6 | 14 ± 0.4 | 4 ± 0.3 | Kotzamanis et al. 2001 |
| | Frame | 71 ± 1.4 | 11 ± 1.1 | 15 ± 1.2 | 3 ± 0.4 | |
| | Tails | 73 ± 1.5 | 7 ± 0.7 | 16 ± 1.1 | 5 ± 0.5 | |
| | Mean of waste ² | 70 ± 1.9 | 11 ± 3.1 | 15 ± 0.9 | 3 ± 0.9 | |
| | Intestines | 56 ± 2.8 | 35 ± 2.7 | 8 ± 1.2 | 1 ± 0.2 | |
| Salmon | Head | | 16 | | | Mbatia 2011 |
| Salmon | Head | 71 | 3.9 | 14 | 3.9 | Jayasinghe & Hawboldt |
| | Viscera | 78 | 1.8 | 17 | 1.8 | 2012 |
| Salmon | Viscera | 59 | 24 | | | Sun et al. 2006 |

² Weighted mean of heads, frames and tails

Fish waste utilization

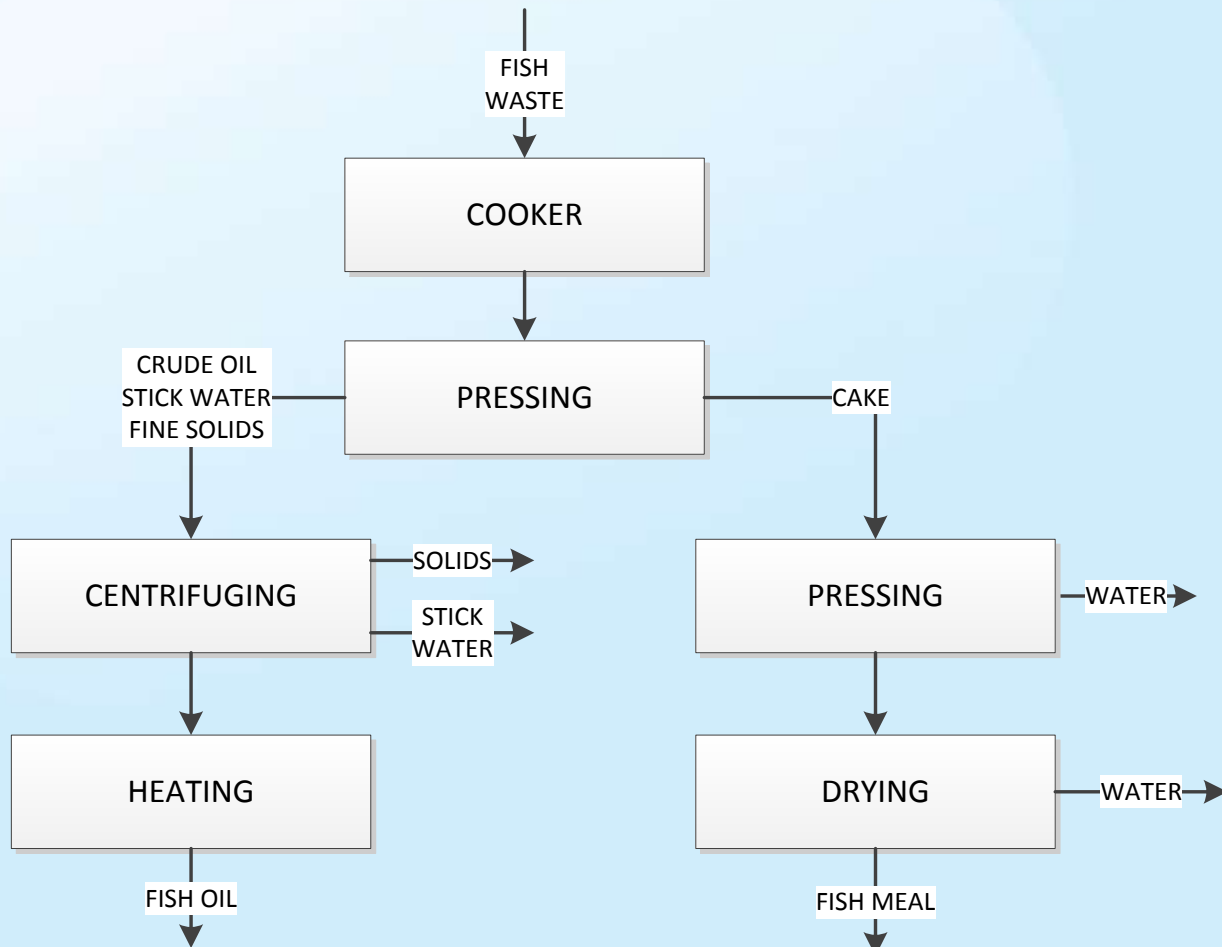


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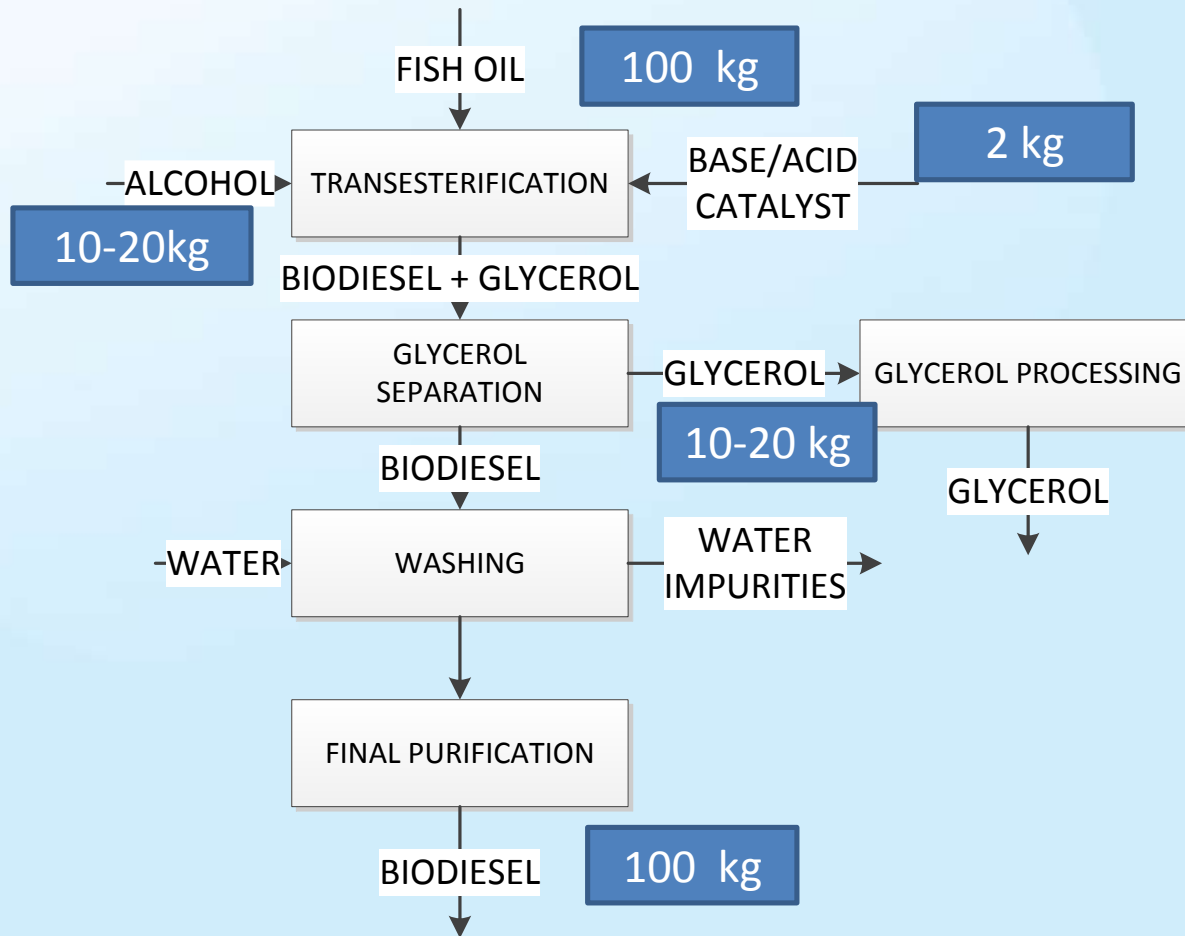
- Fish oil and biodiesel production
- Biogas production
- Animal fodder
- Fertilizers
- Industrial applications of fish oil
- Medical applications of fish oil



Fish oil separation



Fish oil biodiesel



Anaerobic digestion

- Requires also other waste materials
- Wet digestion
- CHP (electricity and heat)



Fish waste to energy potential in Republic of Karelia



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| | Fish waste |
|--------------------------|------------|
| | t/a |
| LLC "Rayguba" | 560 |
| PE N.V. Fedorenko | 150 |
| Ltd. "Kala ja maryapoyat | 150 |
| LLC "Segozerskoye | 300 |
| Ltd. "Nordost Rybprom | 500 |
| LLC "Rainbow | 100 |
| Ltd. "RokFor | 150 |
| Kala Ranta | 170 |
| Ladozskaja Forel | 500 |
| Total | 2580 |

Oil (35%)

900 t/a

As biodiesel

6.5 GWh/a

Anaerobic digestion

Net electricity 1.3 GWh/a

Net heat 1.4 GWh/a



Fish waste to energy scenarios

Scenario 1: Small scale biodiesel production

200 t/a fish waste

→ 60 cars (7 l/100 km, 20 000 km/a)

Scenario 2:

Biodiesel production (BD) or anaerobic digestion (AD)

Northern plant (950 t/a)

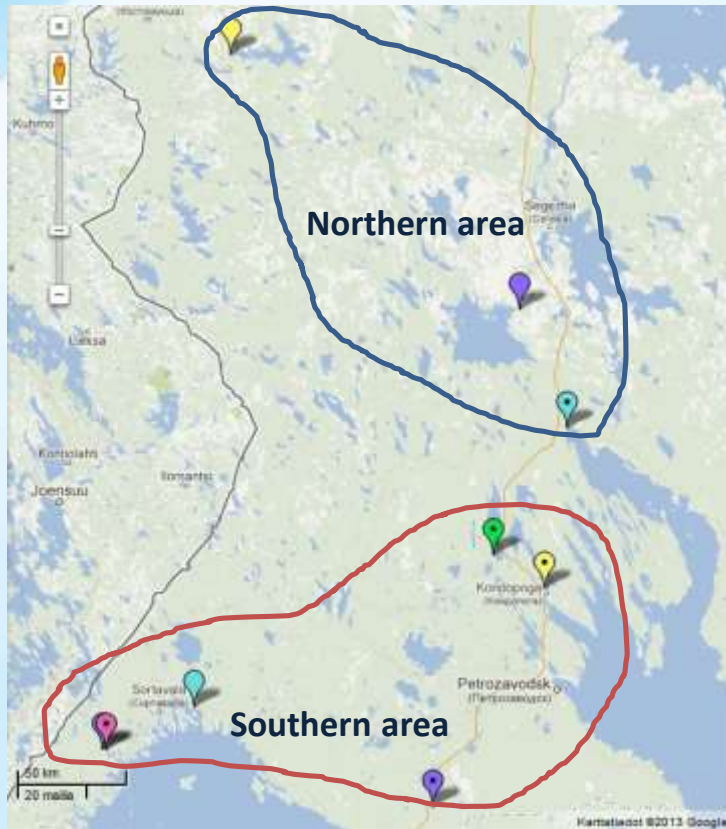
→ Biodiesel 280 cars

→ AD: heat for 35 and electricity for 90 homes

Southern plant (1600 t/a)

→ Biodiesel 480 cars

→ AD: heat for 60 and electricity for 150 homes



Manure biogas



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- Manure potential of 19 farms
 - Mainly cattle manure
 - Manure amount: 340 000 t/a
 - Net electricity 19 GWh/a and net heat 16 GWh/a

- Five interested farms about anaerobic digestion
 - Manure amount 105 000 t/a (31% from total manure amount)
 - Net electricity 8 GWh/a and net heat 7 GWh/a



Manure biogas



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- 3 Farms
- Centralized plant
- Manure
- 45 000 t/a
- Electricity 2.3 GWh/a
- Heat 2.1 GWh/a



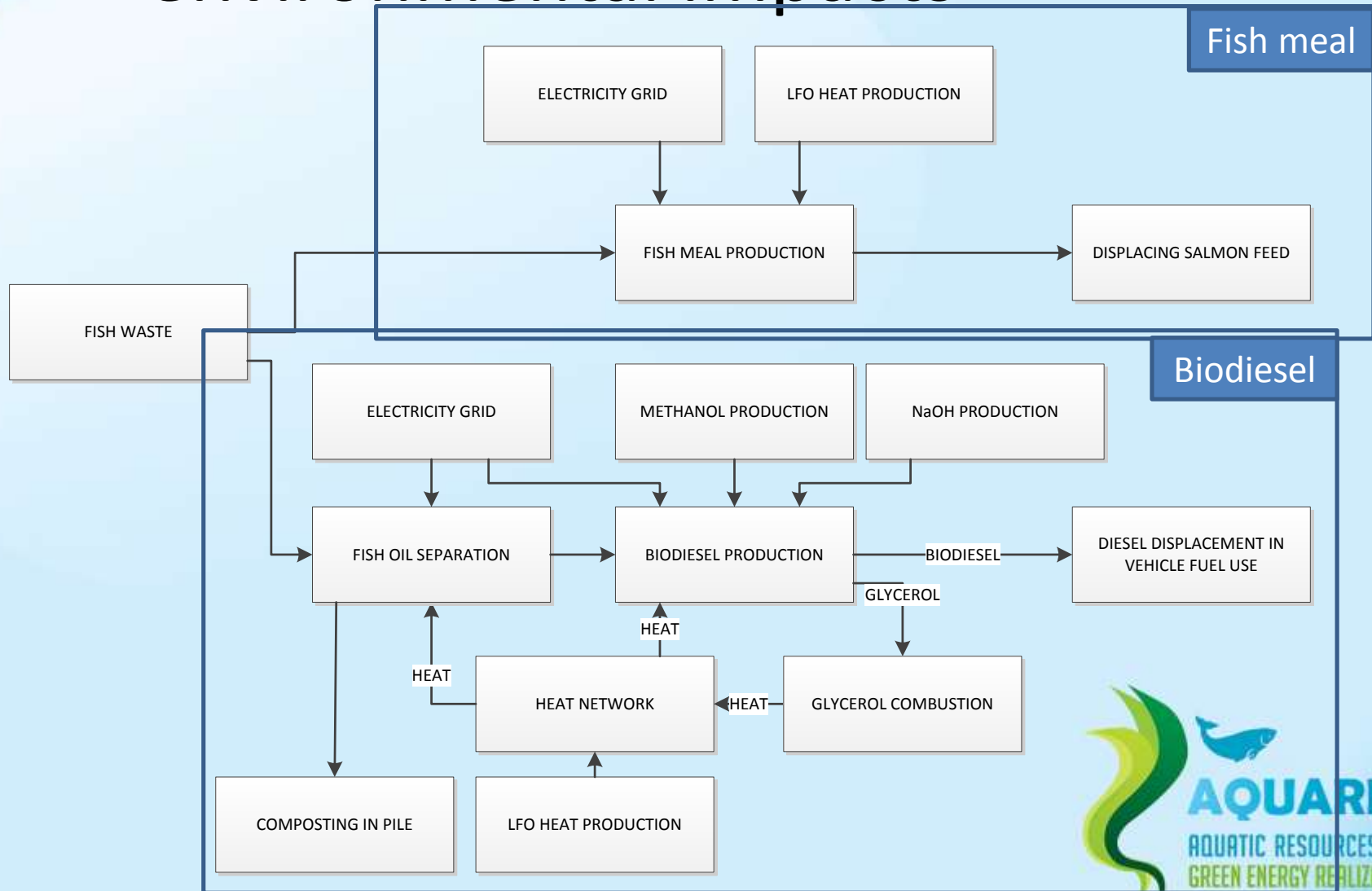
Potential in Republic of Karelia

- Fish waste 2 600 t/a
Biodiesel 900 t/a (10 GWh/a)
- Manure 340 000 t/a
Biogas 85 GWh/a
19 GWh/a net electricity and 16 GWh/a net heat)
- Sewage sludge 11 000 t/a
Biogas 3 100 MWh/a
0.64 GWh/a net electricity and 0.61 GWh/a net heat)

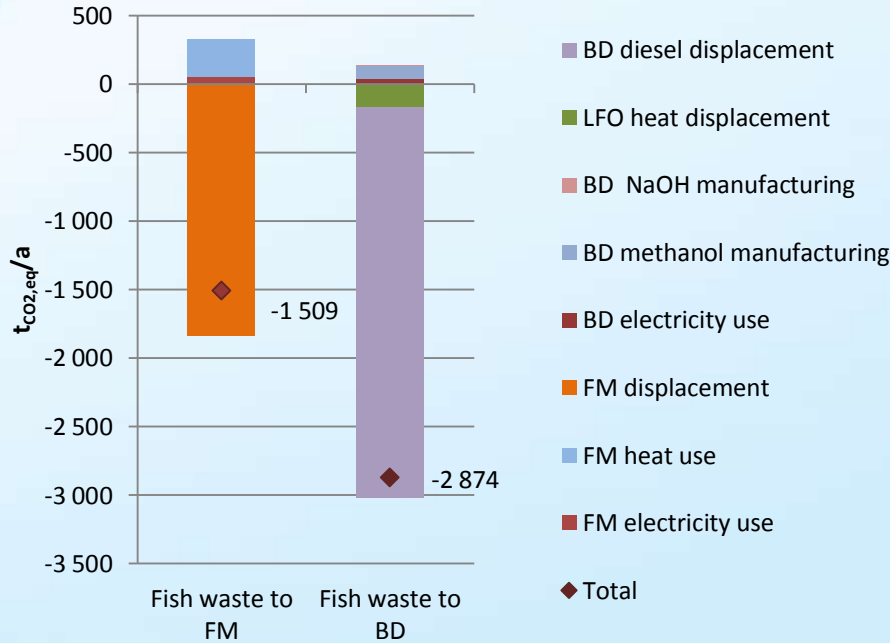
Together: Fuel for 750 car
 Electricity 3 600 homes
 Heat 1 100 homes



Fish waste utilization: comparing environmental impacts



Fish waste utilization environmental impact



Fish meal from fish waste

0.3 kg_{CO₂,eq}/kg fish meal

Compared to:

1.6 kg_{CO₂,eq}/kg average salmon feed

Biodiesel production

3.8 g_{CO₂,eq}/MJ

Compared to:

83.8 g_{CO₂,eq}/MJ

(Directive 2009/28/EC)

GHG emission balance when utilizing all fish waste in Karelian Region 2580 t/a

Fish meal production (oil + protein)

- 1 200 t/a

OR

Biodiesel

- 900 t/a (1 000 000 l/a)



Conclusions

- Unutilized potential exists for recovery from waste in Republic of Karelia
- Biodiesel shows higher net GHG reduction potential than fish meal
- At the moment the economy seems to favor fish waste utilization as fish meal



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Thank you for attention!

