Waste to Biorefinery

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Industrial Symbiosis - competitive edge from material efficiency
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Overview of main biorefining routes from waste

- **Feathers**
  - Mechanical processing
  - Chemical processing
  - Bioprocessing

- **Wood-based waste (energy)**
  - (Chemo)Mechanical preprocessing
  - Bioprocessing
  - Fibers
  - Polymers
  - Sugars

- **Food waste**
  - Anaerobic fermentation
  - Biogas

- **Fish waste**
  - Acidification
  - Heating
  - Esterification
  - Biodiesel
  - Glycerol

- **Used cooking oil**
  - Protein
  - Oil
  - Fish bones

- **Slaughter house waste**
  - Grinding
  - Enzymatic fractionation of protein
  - Protein
  - Bone meal

- **Paper**
- Mouldable packagings
- Plastics
- Feed protein

- **Fiber materials**
- Coatings, films
- Dissolving pulp (textiles)
- Polymer precursors → polymers → plastic
- Bioethanol

- **Higher value end products than biodiesel under discussion in the commission!**

- **Collagen and other proteins**
  - Oil (human consumption, energy)
  - Phosphorous and other minerals (fertiliser)

- **Rehu**
  - Fish waste
  - Grinding
  - Enzymatic fractionation of protein
  - Protein
  - Bone meal
  - P-recovery
  - Collagen and other proteins
  - Fertiliser
  - Feed
FP7 Enerfish: From fish waste to energy poly-generation and integrated cooling energy at fish production industry in Vietnam

Cold storage of fish products

Biodiesel 13 t/d (x & CO2-cooling energy 400 kW)

Fish waste oil separation 18 t/d

Fish fillet production

Fish farming 120 t/d

Fish waste

Feed stuff (protein)

Bio-diesel markets

National power network

Local system

x) Fish production plant is principally energy self-sufficient

Fish flow

Energy flow
EU FibreEtOH – Bioethanol from paper fibres separated from solid waste

- Project objective is to demonstrate for the first time globally in a commercial scale a cost efficient paper fibre based ethanol production

- Process characteristics
  - Recycled waste fiber and fiber sludge from UPM pulp and paper mill as the raw material
  - Cheap price
  - No pretreatment required for effective enzymatic hydrolysis
  - Thermoenzymes in use in high temperature prehydrolysis (55°C)
  - Near-site enzyme production
  - Continuous processing in high dry matter content (~30%)
  - "Quick and dirty" approach to hydrolysis and fermentation because the rest of the valuable sugars are used in biogas production

- Project duration 2010-2013, 16 M€
- UPM-lead consortium with VTT, Roal Oy, AB Enzymes GmbH, Pöyry, Kemiinformation AB, L&T and St1 as project partners
The focus of APROPOS is to develop eco-efficient biomechanical processing solutions to enrich value fractions from process co-streams of fish filleting and oil pressing and utilising the residue for crop protection and soil improvement.

EU-APROPOS — wasteless biorefinery
Sustainable processing of industrial co-streams to value products

- Oil
- Oilseeds
- Fish
- Fish fillets
- Cold-pressed residue
- Mechanical/ enzymatic enrichment
- Heat and enzyme-aided separation
- Food and skin care applications
- Oil
- Phenolics
- Protein
- Glucosinolates
- Residue
- Crop protection, soil improvement

Oil

Glucosinolates

Protein

Residue

Phenolics

Food and skin care applications