Overview

• Introduction to IBioIC

• BioResource Mapping Tool
  • Genesis and aims
  • Approach
  • Tool outputs
  • Opportunities
IBioIC

• Industrial Biotechnology Innovation Centre

• Connect and support
  • Funding, events, skills, tech advice, and equipment centres

• Member organization— >120 members
How did we get here?

- National Plan for IB (2013)
- The Biorefinery Roadmap for Scotland (2015)
- Biorefining Potential for Scotland (2017)
  - ZWS, IBioIC
- National Plan for IB, Driving Progress to 2025 (2019)

Goals:
- £900M in turnover
- >200 IB companies

www.IBioIC.com
Imagineing a biorefinery

Biomass → Detaneraion technology → Biorefinery → Bio-catalytic conversion

- Fuels: Ethanol, biodiesel
- Solvents: Acetone, butanol, THF
- Bulk chem: Sucrose, succinic acid
- Plastics: Thermoplastics, starch
- Fibers: Cellulosic fibers
- Fine chem: Isosorbides, lactic acid esters
- Oils: Corn oil, triglycerides
BRMT aims

- ID critical data sources on arisings of materials valuable in biorefining industries
- Critically assess the quality of these data sources
- Map quantifiable material arisings across Scotland
- Estimate the quantity of AVAILABLE arisings based on known fates
- Generate useful figures for available bioresource arisings regionally across Scotland
Approach

Materials Arising

BioResource Arising

BioResource Content

Accessibility Constraints

BioResource Available
Materials arisings

• Waste (SEPA)
  • MSW and C&I

• Food & drink by-products (SEPA)

• Agricultural residues (Sector studies and reports)

• Wastewater and sludge (Scottish Water)

• Non-exhaustive
  • Ex. Marine, forestry, etc.
## BioResource content

<table>
<thead>
<tr>
<th>BioResources of Interest</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter content</td>
<td>% wet weight (w/w)</td>
</tr>
<tr>
<td>Metabolisable energy</td>
<td>MJ/kg</td>
</tr>
<tr>
<td>Protein</td>
<td>% w/w</td>
</tr>
<tr>
<td>Fat</td>
<td>% w/w</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>% w/w</td>
</tr>
<tr>
<td>Carbon content</td>
<td>% w/w</td>
</tr>
<tr>
<td>Hydrogen content</td>
<td>% w/w</td>
</tr>
<tr>
<td>Nitrogen content</td>
<td>% w/w</td>
</tr>
<tr>
<td>Sulfur content</td>
<td>% w/w</td>
</tr>
<tr>
<td>Total dietary fibre</td>
<td>% w/w</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Zinc (Z)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>% w/w</td>
</tr>
<tr>
<td>Stability</td>
<td>3 → 2 → 1</td>
</tr>
<tr>
<td>Potential to separate source</td>
<td>Y/N</td>
</tr>
<tr>
<td>Functional ingredients for recovery</td>
<td>-</td>
</tr>
</tbody>
</table>
BioResource availability

• Availability constraints/fates
  • Some are positive
    • Recycling, Reuse, Composting/digestion, Animal feed

• Is there un-realised value?

• Pricing model considerations
  • Market values
  • Transportation costs
Approach revisited

Materials Arising

BioResource Content

BioResource Arising

BioResource Arising

Accessibility Constraints

BioResource Available
Model outputs—Materials arisings

- 27,000,000 tonnes/years
- 6-axle lorry = 44 tonnes
  → ~12,000 lorries/week
- Tremendous opportunity
  - Arisings as commodities
Model outputs—By-products arisings

- Prominent generators
  - Distilling—3m tonnes
    - Aberdeen, Fife, and South Ayrshire
  - Cheesemaking—500k tonnes
    - Dumfries and Galloway
Model outputs—Waste arisings

Residential and commercial hubs

- Wood wastes
- Vegetal wastes
- Rubber wastes
- Paper and cardboard wastes
- Other wastes
- Animal faeces, urine and manure
- Animal and mixed food waste
Model outputs—Agricultural arisings

• Largest potential feedstock

• Aberdeenshire and Dumfries and Galloway

• Large volume resources
  • Farm slurry and manure
    • 14M tonnes
  • On-field/harvested waste material
    • 136k tonnes of carrots and potatoes
Model outputs—Protein

Heatmap

Arisings table

<table>
<thead>
<tr>
<th>Material feedstock/current destination</th>
<th>Protein arisings (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draff (whisky)/animal feed</td>
<td>142,956</td>
</tr>
<tr>
<td>Distiller’s dried grains with solubles (DDGS) (whisky)/animal feed</td>
<td>75,375</td>
</tr>
<tr>
<td>Pot ale (whisky)/to sea and rivers</td>
<td>69,552</td>
</tr>
<tr>
<td>Animal and mixed food waste/landfilled</td>
<td>16,906</td>
</tr>
<tr>
<td>Spent grain (beer)/animal feed</td>
<td>12,159</td>
</tr>
<tr>
<td>Animal and mixed food waste/RRC*</td>
<td>8,512</td>
</tr>
<tr>
<td>Whey (dairy)/animal feed</td>
<td>3,763</td>
</tr>
<tr>
<td>Potatoes — potato haulms/to land</td>
<td>3,502</td>
</tr>
<tr>
<td>Spent yeast (beer)/to sea and rivers</td>
<td>1,786</td>
</tr>
<tr>
<td>Animal and mixed food waste/recovered</td>
<td>1,520</td>
</tr>
<tr>
<td>Pot ale (whisky)/pot ale syrup</td>
<td>1,104</td>
</tr>
<tr>
<td>Carrot stalks and leaves/to land</td>
<td>817</td>
</tr>
<tr>
<td>Brassica tops/to land</td>
<td>642</td>
</tr>
<tr>
<td>Carrots – harvested waste/animal feed</td>
<td>636</td>
</tr>
<tr>
<td>Carrots – harvested waste/landfill</td>
<td>636</td>
</tr>
<tr>
<td>Whey (dairy)/digestion</td>
<td>205</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td><strong>340,858</strong></td>
</tr>
</tbody>
</table>

* Re-used, Residues, Composted

Price Curve

Materials/fates

+ Accessibility -
Opportunities

• By-products from whisky production
  • 2m tonnes disposed, 600k tonnes to animal feed (2015)
  • Source of protein and carbohydrates
• Fruit and vegetable waste
  • Abundant source of carbohydrates and fibres
  • Low-yield, high-value (flavors, colors, vitamins)
• Animal and mixed food waste
  • Diverse components— protein, carbohydrates, fats,
  • Separation as a challenge
• Organic and waste-based fertilisers
What’s next?

• Include additional materials arisings
  • Forestry, marine (algae), bakery waste, coffee grounds, CO₂

• Additional valuable bioresources

• User interface

• Forecasting pricing and availability
How to obtain information

- IBioIC.com
- “What we do”
- BRMT
- Email a request for information
  - info@ibioic.com