Fortum

Turning Waste into Value – Waste and Recycling business today and tomorrow

KALLE SAARIMAA / VP, Fortum Recycling and Waste
September 2019
Fortum in brief

Our core
Hydro and nuclear
Combined heat and power production
Circular economy
Energy-related products and expert services

The largest electricity retailer in the Nordics and one of the leading heat producers globally. We have 2.5 million customers.

96% of our power generation is CO₂ free in Europe, 57% in all operations

~45 TWh of our power generation is hydro and nuclear

8,300 professionals in the Nordics, the Baltics, Russia, Poland and India

96% of our power generation is CO₂ free in Europe, 57% in all operations
Fortum’s strategy builds on our vision – *For a cleaner world*

1. **Pursue operational excellence and increased flexibility**
2. **Ensure value creation from investments and portfolio optimisation**
3. **Drive focused growth in the power value chain**
4. **Build options for significant new businesses**

- Increasing uncertainty
- Competitive benchmark portfolio

Illustrative 2020’s 2030’s

Today
Fortum City Solutions – leading player in heating, circular economy and solar

1) Fortum Oslo Varme consolidated from August 2017 onwards
2) Does not include Other Operations
Fortum Recycling and Waste - Operations in the Nordics

30 offices/treatment centers
- Finland
- Sweden
- Denmark
- Norway

Around 650 employees
- In the Nordics

Recycling
- Refineries to recycle plastics, metals, ash and li-ion battery chemicals

High temperature incineration
- In order to treat hazardous waste

Waste-to-Energy
- In order to treat municipal solid waste and industrial waste

Revenue development of Fortum’s Recycling and Waste business EUR million

Finland
- Riihimäki
  - Plastic refinery
  - High temperature incineration
- Ikaalinen
  - Metal recycling
- Pori
  - Ash refinery
- Harjavalta (Crisolteq)
  - Li-ion battery recycling plant

Sweden
- Kumla
  - High temperature incineration
- Waste-to-Energy plant

Denmark
- Nyborg
  - High temperature incineration
Fortum’s recycling business constantly developed

- **2016**
  - Ekokem
  - Turebergs Recycling

- **2018**
  - Plastic recycling capacity investments
  - Fincumet acquisition

- **2019**
  - Crisolteq convertible bond
  - Divestment of oil collection business in DK+FIN
There is a global need for responsible waste treatment and recycling

- **Urbanization and population growth**
  We need to use natural resources more efficiently and retain the value in waste

- **Global waste problem and growing awareness of it**
  Brand owners want to move to using recyclable products and packaging

- **Need to reduce CO\textsubscript{2} emissions**
  We will see landfill bans and incentives for increasing recycling and waste-to-energy
This challenge has been recognized – recycling and waste industry are developing fast in Europe

- China banned waste imports in 2018
  - Many European countries are looking for alternative ways to handle their waste
- In the EU at least half of the recyclables collected are ultimately incinerated, exported, or even landfilled
- EU regulations relating to recycling and waste are becoming stricter:
  - Sanctioning of companies that generate excessive CO₂ by 2020
  - All plastics in the EU needs to recyclable by 2030
  - 20 minerals now on critical material list
- Electrification of transportation and other parts of the society
  - The recycling market will grow significantly by 2030

**European municipal solid waste will shift to recycling, Waste-to-Energy remains important**

<table>
<thead>
<tr>
<th>Year</th>
<th>Landfill/other</th>
<th>WtE</th>
<th>Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>485</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assumes 50% recycling in 2025, 30% in WtE, 20% in landfill/other
The recycling market for plastics and batteries is expected to grow significantly over time.

Plastics volumes remain stable, shift towards recycling

Volume (Mt)

Europe

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-recycled</th>
<th>Recycled</th>
<th>Recycling value (USD bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>25</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>27</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>25</td>
<td>10.0</td>
<td></td>
</tr>
</tbody>
</table>

Global

<table>
<thead>
<tr>
<th>Year</th>
<th>Recycling value (USD bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>1.8</td>
</tr>
<tr>
<td>2030</td>
<td>23.7</td>
</tr>
</tbody>
</table>

- EU target is 55% of plastic packaging recycled; China plastic import ban
- Average price of secondary (granulate) plastics ~$715/ton

Lithium-ion battery recycling market

USD bn

- 2017: 1.8 USD bn
- 2030: 23.7 USD bn
Demand for recycled products is growing

• Consumer demand for recycled products has already grown significantly and will continue to grow
• Global companies demand more recycled materials and want to make products from them
• In many cases products made from recycled materials carry a price premium over products made from virgin materials

24% ➞ 100%

“"We will make all of our plastic bottles from 100% recycled plastic by 2025"

“"All of our plastic packaging will be rechargeable, refillable, recyclable, or compostable by 2025"

“"We will ensure that 100% of our plastic packaging is fully reusable, recyclable, or compostable by 2025"
Globally most of the plastic packaging is not being recycled.
Three major changes are needed to allow for circular economy of plastics

- Recycling with significantly improved economics and quality: 50%
- Fundamental redesign and innovation of package planning: 30%
- Reuse: 20%
The CO$_2$-free society of the future relies on battery technology

Electrified transportation

Renewable energy system
The increase in the number of electric vehicles drives new demand for critical metals

- **800%** increase in demand of nickel and manganese
- **150%** increase in demand of cobalt

Mining these metals would increase these greenhouse gas emissions by **500%**

Recycling is needed to ensure sustainable supply of critical metals for battery production

Data from Ecoinvent v. 3.1, The Manganese Institute
Batteries contain materials that can be effectively recycled

Discharging of the battery module
Excess energy back to the grid

Dismantling of the battery module into battery cells
Recycled materials
• Ferrous
• Aluminum
• Plastics
• Copper

Mechanical recycling
Plastics and metals are recycled into new raw materials for batteries and applications

Hydrometallurgical recycling
The “black mass” that contains cobalt, manganese and nickel are separated with chemical precipitation methodology

Recycling provides a stable, sustainable and socially acceptable source of raw materials; plastics, metals and scarce metals. Recycling work takes place in Europe.
Why Finland? Strong network of companies in all parts of the value chain

- **Mining**
  - Critical raw materials:
    - Nickel ore
    - Cobalt
    - Lithium
  - Refining:
    - Chemicals and salts:
      - Nickel sulfate
      - Cobalt sulfate
      - Lithium carbonate and hydroxide
  - Chemicals production:
    - Processed materials:
      - Cathode materials
      - Anode materials
      - Electrolyte materials
      - Separators
    - Cells and modules:
      - Battery cells and modules
      - Battery management system
    - First use applications:
      - Consumer electronics
      - EV’s
      - Energy storage
    - Secondary use and recycling:
      - Battery material recycling
      - Secondary use applications

Source: Suomen Malmijalostus
True circular economy needs new thinking to become a reality

Regulation that supports recycling

New technologies

Smart business models
Thank you!