Danish experience with MSW management
Klaus Fafner, Ramboll
IX International Investment Business Forum
Renewable Energy and Energy Efficient Modernization of Industry
November 2017
• Services across the markets:
  - Buildings
  - Transport
  - Environment & Health
  - Water
  - Energy
  - Oil & Gas
  - Management Consulting

Ramboll in brief

• Independent engineering and design consultancy and provider of management consultancy
• Founded 1945 in Denmark
• Over 13,000 experts
• Over 300 offices in 35 countries
• Significant presence in the Nordics, North America, the UK, Continental Europe, Middle East, Asia, Australia, South America and Sub-Saharan Africa

• EUR 1.1 billion revenue
• Owned by Ramboll Foundation
• Ramboll Energy - World leaders in low carbon, district energy infrastructure and waste to energy
• At the forefront of developments in Danish district heating sector for over 40 years
AGENDA

1. The Danish Approach as regards Municipal Solid Waste Management

2. Waste Strategy

3. Impact of Strategy on District Heating

4. Challenges for Energy Recovery Facilities
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115 YEARS OF WASTE INCINERATION IN DENMARK

1903 - Frederiksborg
- First waste incineration plant with CHP

Today
- Extensive waste incineration
115 YEARS OF WASTE INCINERATION IN DENMARK - HIGHLIGHTS

• Waste-to-Energy facilities are public utilities owned by the municipalities and are based on Not for Profit principles

• New energy policy in 1990:
  • Heat primarily to be produced in CHP: Combined Heat and Power plants
  • Existing plants to be converted to CHP

• 1997: Ban on landfilling of combustible waste

• Today waste is regarded a useful fuel for CHP production - for waste that cannot be recycled or reused
  • More than 20% of all district heating is from waste incineration
  • 5% of electricity is from waste incineration
THE DANISH APPROACH: MAIN FOCUS ON WASTE INCINERATION

- Waste incineration makes a significant contribution to reduction of CO2 emissions.
- Waste incineration minimize the landfilling of waste. Just 6% of Denmark’s waste ends up in a landfill.
- Danish waste incineration plants are the cleanest and most efficient in the world, generating approx. 2 MWh heat and 2/3 MWh electricity from every ton of waste incinerated.
- A new strategic approach to waste is to encourage recycling over incineration. By 2022, 50% more household waste will be recycled instead of incinerated.
MUNICIPAL WASTE TREATMENT IN 2015
EU 28 + SWITZERLAND, NORWAY AND ICELAND

* : 2014 data (most recent data available)
** : 2012 data (most recent data available)

Source: Eurostat 2017

Graph by CEWEP
TYPICAL DISTRIBUTION OF INCINERATION COSTS and income

- Labour costs: 20%
- Material and resource consumption: 15%
- External services: 19%
- Other costs: 7%
- Amortisation: 23%
- Interest payment: 16%

- Gate fees: 49%
- Electricity: 21%
- Heat: 30%

Source: RAMBOLL
AMAGER BAKKE, COPENHAGEN, DENMARK

- Green-field WtE facility
- Capacity: 2 x 280,000 tonnes of waste annually
- Energy output: 400,000 MWh electricity and 1,000,000 MWh heat per year
- From project analysis and planning to take over
- Owners Engineer on M&E, site management
- Commissioning: 2016
KARA/NOVEREN, ROSKILDE, DENMARK

- New waste-to-energy unit
- 200,000 tpa
- From project analysis and planning to take over
- Owners Engineer on M&E
- Commissioning: 2013
I/S NORDFORBRÆNDING, DENMARK

- New unit for waste-to-energy facility
- 96,000 Tpa
- From project planning to take over
- M&E advisor and Owners Engineer
- Commissioning: 2016
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TIMELINE OF REGULATION AND STRATEGIES

Energy crisis  Responsibility for Communal Waste switches to Municipalities

1970
- Hazardous waste
- Environmental regulation of landfills

1990
- Recycling of paper and glass
- Tax on landfill and incineration
- Regulation of commercial waste

1997
- Recycling stations
- EU Landfill ban

2006
- Electronically waste (EU producer responsibility)
- Packaging waste (EU regulation demand)

2014
- EU Roadmap and resource plan
- Planning a future without waste in Denmark

Planning a future without waste in Denmark
ROADMAP TO A RESOURCE EFFICIENT EUROPE FROM 2011:

Denmark became member of EU in 1973

EU MILESTONES BY 2020:

- Waste is managed as a resource
- Waste generated per capita is in absolute decline
- Waste legislation is fully implemented
- Energy recovery (by waste-to-energy) is limited to non recyclable materials
- Landfilling is virtually eliminated
- High quality recycling is ensured
THE STRATEGIC WASTE HIERARCHY

Prevention
Preparation for re-use
Recycling
Other recovery
Disposal

Most favoured option

Least favoured option

Waste prevented
Waste collection
Waste generated
Waste recycled and re-used
Other Recovery
Waste landfilled
CIRCULAR ECONOMY AND WASTE HIERARCHY

Energy Recovery Facilities

- ERF important measure to ensure energy recovery from “last cascade” of recycling
- ERF important measure to ensure a safe sink for polluted materials
- ERF can ensure recovery of the small metal fractions
WASTE HIERARCHY AND COST INCENTIVES

RECYCLING

- Pre-sorting and recycling
- “Free” entrance for households
- Gate fee for companies: 20-60 €/visit
- 20-30 waste types

WASTE TO ENERGY

<table>
<thead>
<tr>
<th>Average fee 2011</th>
<th>$/ton</th>
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<tbody>
<tr>
<td>Fee</td>
<td>42</td>
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<tr>
<td>Tax</td>
<td>39</td>
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<tr>
<td>Gate fee</td>
<td>81</td>
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LANDFILL

<table>
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<th>Average fee 2011</th>
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<td>Fee</td>
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<td>Tax</td>
<td>85</td>
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<tr>
<td>Gate fee</td>
<td>150</td>
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</table>
GATE FEES IN EUROPE

[Bar chart showing gate fees in euros per tonne for various European countries]

[Bar chart showing gate fees excl. waste tax for different production scenarios]

Denmark, Sweden, Portugal, UK, Switzerland, Netherlands, Germany

No energy production, Production of power only, CHP production
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# WASTE INCINERATION AND DISTRICT HEATING IN DENMARK

<table>
<thead>
<tr>
<th>Main DH systems</th>
<th>Systems</th>
<th>Average Produced</th>
<th>Waste Biomass CHP heat</th>
<th>Biomass CHP heat</th>
<th>Surplus heat</th>
<th>Solar thermal ChP heat</th>
<th>Geo-thermal Fossil ChP heat</th>
<th>Fossil heat</th>
<th>Share</th>
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<tbody>
<tr>
<td>Denmark 2010</td>
<td></td>
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<tr>
<td>Greater Copenhagen</td>
<td>1</td>
<td>3.386 GWh</td>
<td>9.481 GWh</td>
<td>2.223 GWh</td>
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<td>161 GWh</td>
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<td>Aarhus DH</td>
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<td>1.063 GWh</td>
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<td>Aalborg</td>
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<td>587 MW</td>
<td>1.761 GWh</td>
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<td>PP extraction</td>
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<tr>
<td>Waste + Biomass SC</td>
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<td>52 GWh</td>
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<td>89 GWh</td>
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<td>Gas SC/CC</td>
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<td>8 GWh</td>
<td>5.812 GWh</td>
<td>156 GWh</td>
<td>178 GWh</td>
<td>19 GWh</td>
<td>9 GWh</td>
<td>10 GWh</td>
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<td>Bioenergy etc.</td>
<td>112</td>
<td>8 GWh</td>
<td>2.898 GWh</td>
<td>120 GWh</td>
<td>2428 GWh</td>
<td>115 GWh</td>
<td>87 GWh</td>
<td>17 GWh</td>
<td>18.667</td>
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<tr>
<td>Sum</td>
<td>377</td>
<td>33.781 GWh</td>
<td>6.965 GWh</td>
<td>3.218 GWh</td>
<td>2079 GWh</td>
<td>961 GWh</td>
<td>27 GWh</td>
<td>169 GWh</td>
<td>18.667</td>
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<tr>
<td>Share</td>
<td></td>
<td>100%</td>
<td>21%</td>
<td>10%</td>
<td>6%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>55%</td>
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COPEHAGEN – THE BIGGEST DISTRICT HEATING SYSTEM WITH ENERGY FROM WASTE

**Facts**

- 160 km pipe mains
- 30,000 TJ/a heat sold
- 60 mill. M² floor area heated
- 110 kg CO₂/MWh
- 25 % Waste-to-Energy
- 97 % CHP production mode
WASTE-TO-ENERGY AND DISTRICT HEATING
AN ELEMENT OF SMART ENERGY SYSTEMS

Balancing supply and demand

Merit order of production to minimise cost and carbon emissions

Energy and price forecasting to avoid spilling and to maximise value of within the power market (NORDPOOL)

Capturing, storing and dispatching “free heat”

Minimising heat losses through continuous optimisation
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CHALLENGES FOR ENERGY RECOVERY FACILITIES

- Prioritized heat production
- Located in city suburbs
- Built to toughest emission standards
- Highest efficiencies through flue gas heat recovery
- Designed for public acceptance through good architectural design
- Good neighbors
CHALLENGES FOR ENERGY RECOVERY FACILITIES

- Commercial and Financial Environment
  - High investment costs and long development timescales
  - Risk reward profile deters private sector and 3rd party investors
  - Immature supply chain drives up costs
  - Complex stakeholder arrangements

- Policy environment
  - No direct support for heat networks
  - Policy instability at national level
  - Local planning policy - insufficient leverage

- Technical challenges
  - Retrofitting costs (building temperatures and heating systems)
  - Development density
  - Existing utilities and grid connection
  - Supply chain lacks capacity and knowhow

- Capacity and appetite to deliver
  - Internal resources, funds, relevant skills
  - Access to finance
  - Appetite for risk
Provide a clear indication of **Government policy** which will shape the actions of local self-government units and give confidence in relation to investment.

Relieving the pressure on the extraction of **raw materials** through the reuse of products and the recycling of paper, glass, plastic etc.

A reduction of **greenhouse gas emissions** (e.g. through increasing diversion of biodegradable waste to landfill and managing LFG by flaring or utilization);

An increase in **job opportunities** in the waste sector and recycling sector;

An enhanced environment and a **cleaner and safer place to live**, through the prevention of pollution to ground, water and air, and reduced litter by the provision of safe landfills operated to best international practice.
ДЯКУЮ ЗА УВАГУ!
THANK YOU FOR YOUR ATTENTION!

KLAUS FAFNER

KLF@RAMBOLL.COM
WWW.RAMBOLL.COM
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