
CO-CREATION WORKSHOP

Monday 10 October 2016 – From 9:00-16:00
Movenpick Hotel, Beirut, General De Gaulle Avenue

Session A: Waste-to-Energy and Solid Waste Management

- 09:45 – 09:50: Introduction to workshop by moderator Ib Larsen, Solid Waste Management Senior Advisor
- 09:50 – 10:10: Integrated Solid Waste Management for Beirut: UNDP proposal, Edgard Chehab, UNDP Assistant Resident Representative
- 10:10 – 10:45: Presentation of general options for urban waste management and the Copenhagen waste management system, by Senior Advisor Ib Larsen
- 10:45 – 11:05: Establishing and operation of state-of-the-art WtE plants, experience from Amager Resource Center, by CEO Ulla Röttger, ARC
- 11:05 – 11:25: Establishing and operation of state-of-the-art WtE plants – main factors to address during design, tender and award process, by Project Director Joergen Haukohl, Ramboell
- 11:25 – 12:25 Discussion
- 12:25 – 12:30 Wrap up and conclusions by moderator Ib Larsen



CITY OF COPENHAGEN





CO-creation workshop

Beirut-Copenhagen City Cooperation *Waste-to-Energy and solid waste management*

*Mövenpick Hotel
Beirut
11 October 2016*

Ib Larsen
Senior waste consultant

Introducing Copenhagen

- Capital of Denmark
- 88 km²
- 600.000 inhabitants
- 280.000 households
 - 92% live in flats
 - 8% live in detached houses
- Annual population increase about 10.000
- 355.000 workplaces
- 80.000 enterprises



Responsibility for waste management

- **Waste management is under the authority of the municipality:**
 - decides the strategy and undertakes the planning
 - responsible for waste collection as well as waste processing.
 - finances its activities through a separate waste fee levied on the users and collected together with property tax
 - operates within a framework determined by EU directives and national legislation .

Content of presentation



Options for MSW management

History of waste management, City of Copenhagen

Status and strategies for waste management in Copenhagen

Some requirements for proper waste management – experience from Copenhagen

The waste management system

- **Basic System** **(Robust)**
 - Capacity
(Hygienic, low emission, energy efficient)
 - Flexibility
(Able to manage fluctuations in amount and composition)
 - **Superstructure** **(Sensitive)**
 - High Quality Processing (Clean Fractions)
-

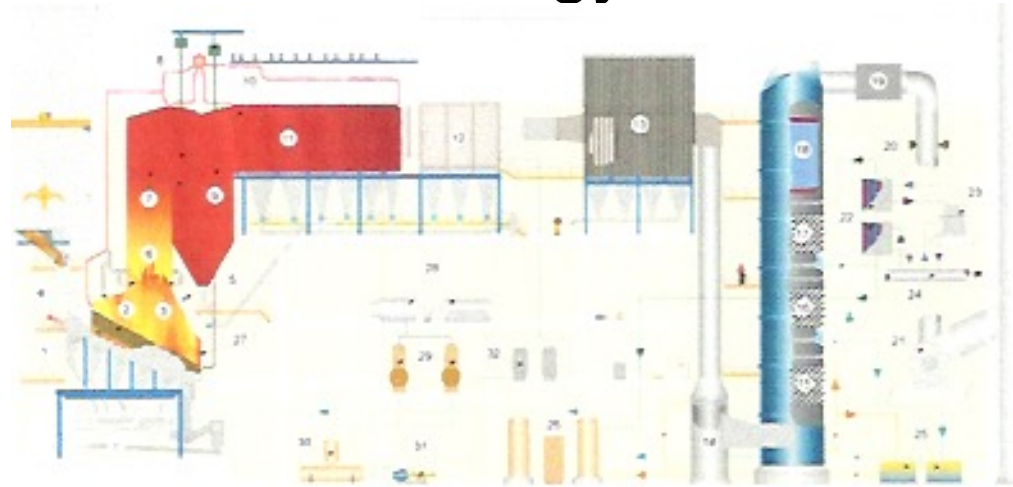
The basic waste management system

- **Depositing (dumpsite/landfill)**
 - High area requirements
 - Leaching through liners
 - Greenhouse gas emission
 - Nuisance: odour, paper flight, infections, visual impact
 - Loss of resources
 - **Thermal decomposition**
 - Minimal area requirements
 - Energy generation
 - Air emissions
 - Disposal of fluegas residues
 - High requirements for operational performance and skills
-

Thermal decomposition

Main thermal decomposition technology

- Grate mass-burn



Alternative thermal decomposition technologies:

- Fluidized bed mass-burn
 - Gasification
 - Pyrolysis
 - Carbonizing
-

Typical waste composition

COMPONENT	LIBANON, BEIRUT (%)	TYPICAL EUROPE (%)
Food and Yard Waste	51	20
Paper	16	40
Plastic	13	6
Metal	3	8
Glass	4	8
Other (textiles, stone, sand, etc.)	11	18
TOTAL	100	100
Moisture content %	50-55	20-25

Thermal treatment of waste with high organic /low CV content.

- Segregate the organic fraction for compost/biogas
- include the organic fraction in waste for thermal treatment



Segregating low CV fraction

- Segregation of 15-20% of the organic material
In Beirut preferred for proper WtE
 - *Retain existing sorting plants (low quality compost)*
 - *Source sorting of organic waste from high-density sources (eateries) (high quality compost)*
 - *Source sorting of organic waste from certain areas (high quality compost)*

Full segregating of organic waste.
thermal treatment or landfilling of residual waste

- Composting
- Biogas/composting

- Very long processing time (2-4 month)
 - Very large area requirements for composting or stabilising of biogas digestate
 - Contamination of compost from mixed organic waste
-

Composting



Wet or dry biogas



Wet Biogas Plants

- Plants operate with feedstock in liquid form
- Requires homogenization and size reduction (20mm)
- High amount of nutrient rich wastewater, that must be treated or distributed in liquid form
- Sand and silt erodes pumps and pipes and settle in digester tank
- Pumps and pipes block by non-conforming waste material

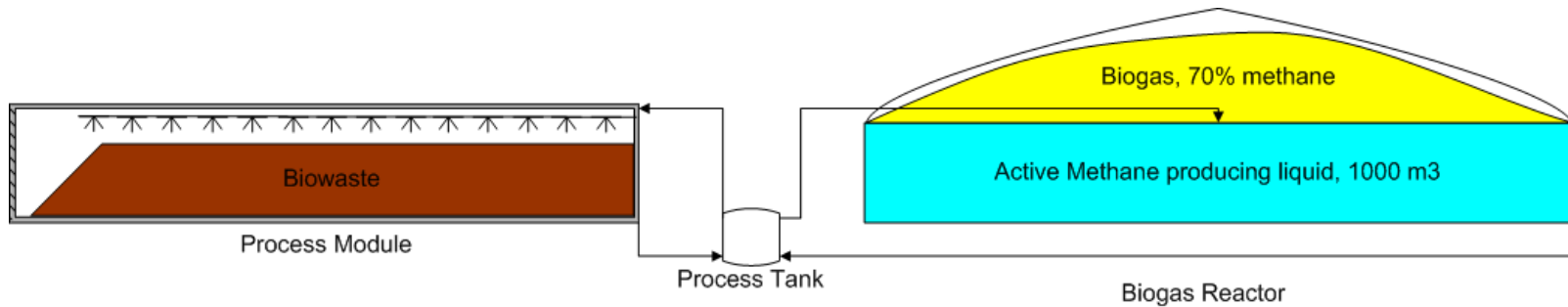


Dry batch Biogas plants for MSW

- Plant operate with waste in solid form
- Very robust against material composition (waste does not move)



Dry Batch biogas Plants



Including low CV fraction for WtE in Asia

India



Vietnam



Thailand



Bio-drying

- Include the organic fraction in the fraction for combustion
- Utilise the heat from the natural decomposing of organic material to evaporate moisture
- Remove the vapor by slight airstream
- 2-3 week drying time

- processes:
 - under semi-permeable membranes
 - in chambers

Generic output from biodrying process

– Asian waste characteristics –
full drying (from 60 to 20-25% moisture)

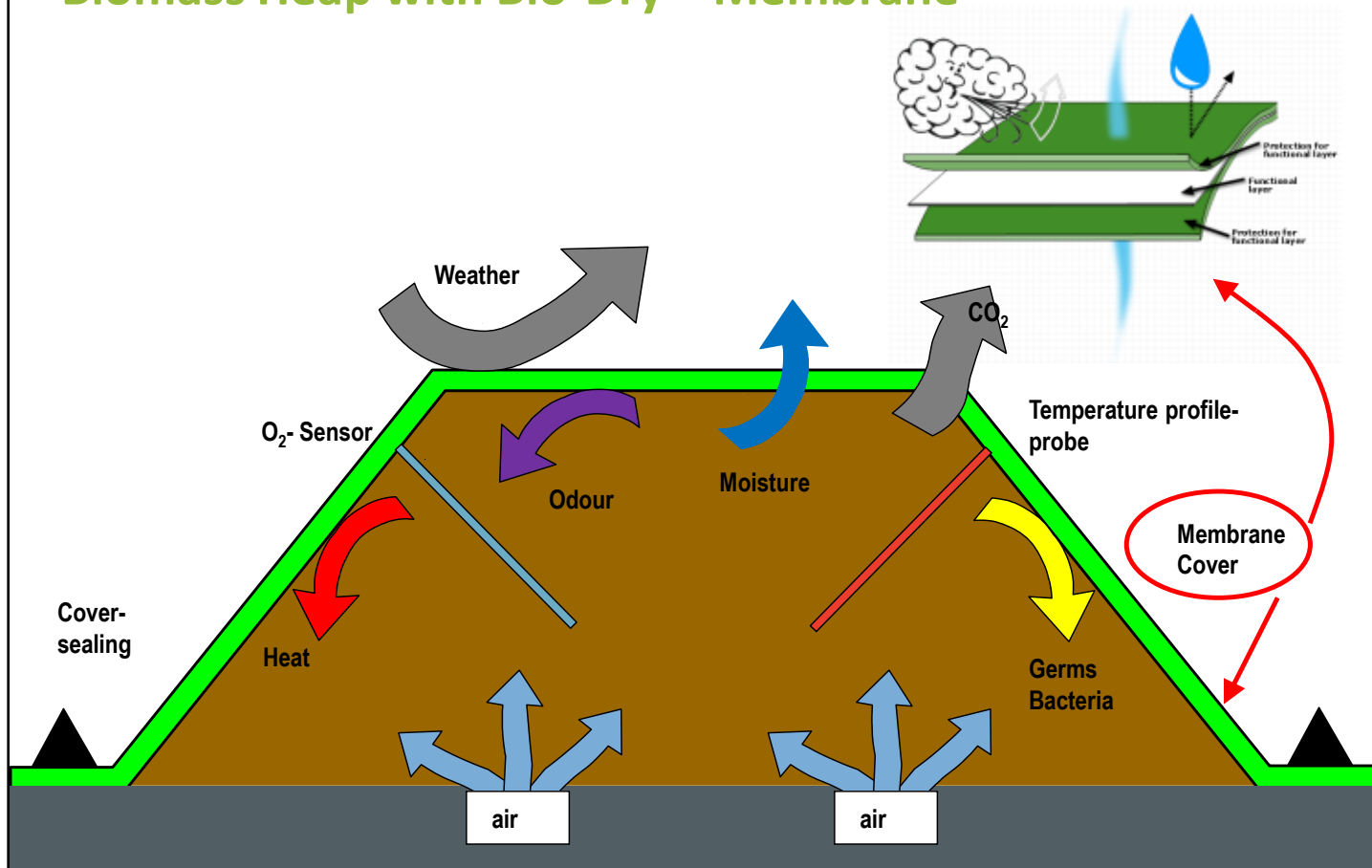
**Outputs from incoming waste:
(1200t/day)**

Evaporation of water	43% (515 ton)
Waste for WtE	35% (420 ton)
Recyclables	3% (35 ton)
Inerts and fines	19% (230 ton)



Membrane bio-drying principles

Bio-Dry™: Cross-Section of Waste or Biomass Heap with Bio-Dry™ Membrane



Membrane bio-drying plant



**Istanbul, Turkey:
2,000t/day**



Chamber bio-drying



**Shanks London
(500tpd)**



Content of presentation



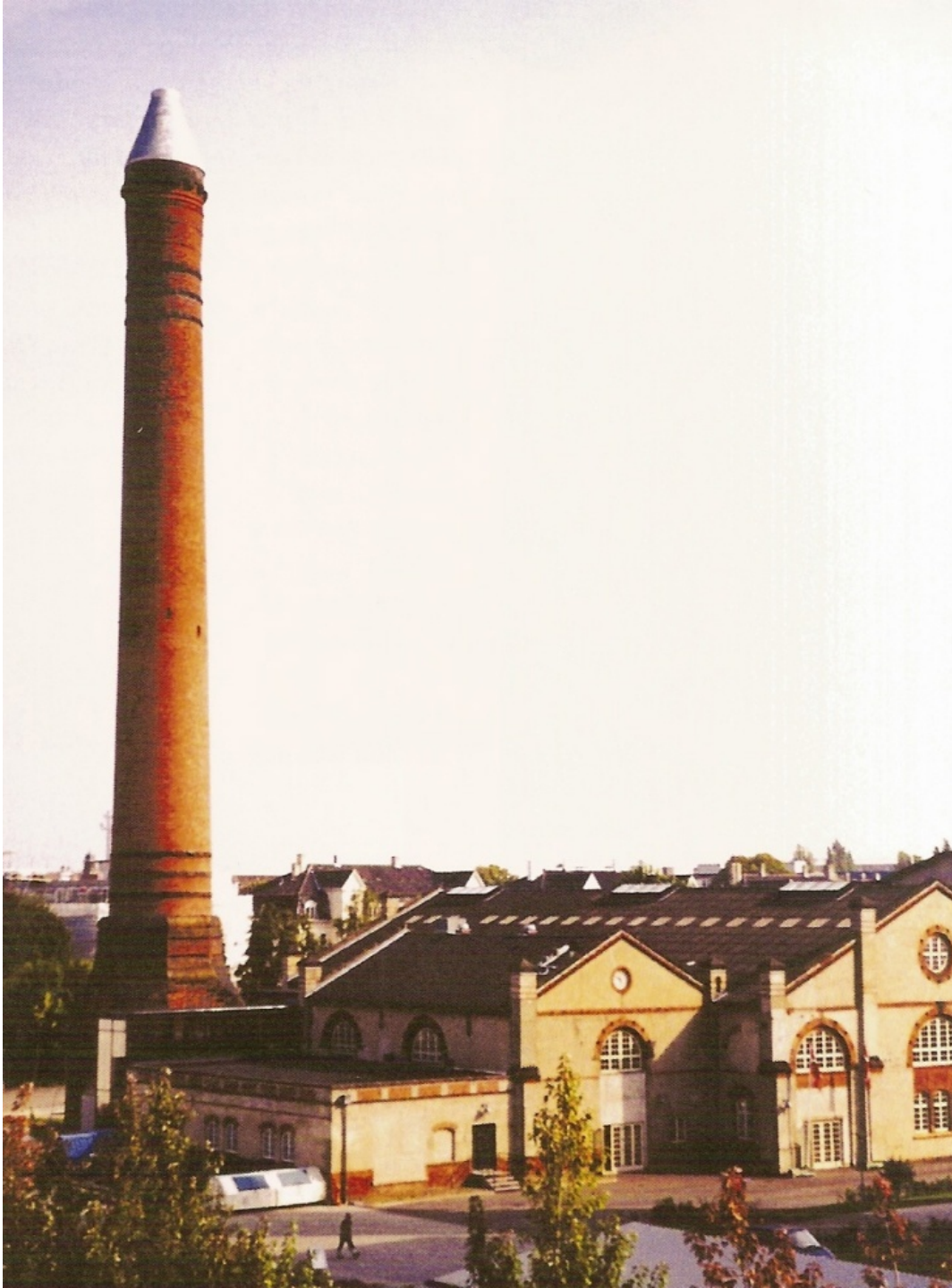
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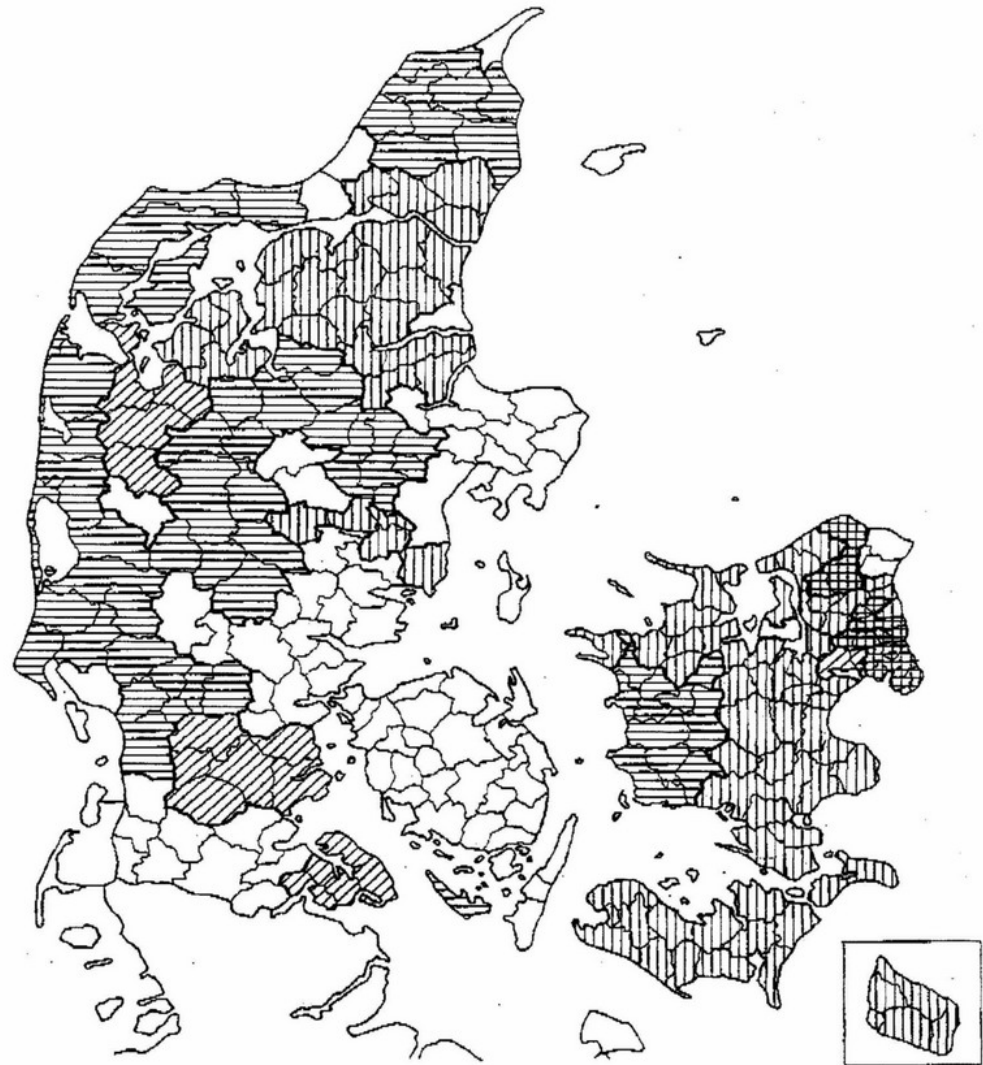
**Frederiksberg municipal
culture & sports centre,
The Boiler Hall.1934**






INCINERATION IN DENMARK

	1960	1970	1978	1986	1994	2003	2008
No. of facilities	2	49	57	39	37	32	29
Average size t/year		9,000		32,000	56,000		100,000



INTER-MUNICIPAL PARTNERSHIPS IN DENMARK



- | | | | | | |
|---|---------------------------|---|------------------------------|---|---|
|  | Affaldsteknisk samarbejde |  | Other companies/cooperations |  | Municipalities without municipal partnerships |
|  | Renosam |  | Under construction | | |

LANDFILLS IN DENMARK

Year	Number
1970	1200
1978	500
1986	82

WtE in Copenhagen

- Two incineration plants established in Copenhagen in 1970
- Both established and operated by Intermunicipal entities formed for the purpose:
 - **Amagerforbrænding (ARC)** located in central Copenhagen
 - **Vestforbrænding** located north-west of Copenhagen
- **Original focus:**
 - Volume reduction
 - District heating
 - Hygiene



Recycling re-introduced in Denmark

- 1975 First neighbourhood container (Glass) (Birkerød)
- 1983 First subdivided bins for household waste (paper) (Farum)
- 1984 First recycling center (Lyngby-Taarbæk)

Waste become political

Environmental impact from waste management

Landfills:

- Leaching through membranes
- Illegal disposal of hazardous substances at landfills
- Greenhouse gas formation

Incineration:

- Acidification
- Air emissions
- Quality of bottom ash
- Content of toxic and unwanted materials

Resource Management:

- Loss of resources
 - Sub-optimized energy utilisation (Global warming)
-

Waste to Energy



Incineration - New Policies:

- Advanced flue-gas cleansing
 - Source sorting of unwanted waste
 - Closure of small facilities
 - Improved operations
 - *Prolonged operation periods*
 - *Prolonged retention time for flue gasses*
 - *Supportive burners for back-up*
 - *Pre-heating of combustion air*
 - Requirements for bottom ash quality
 - *Burn-out level (loss on ignition)*
 - *Leaching of heavy metals*
 - Combined power/heat generation
-

In the Neighbourhood,

Recycling centers

- Paper
- Plastic bottles
- Glass
- Cardboard
- Construction waste
- Metal
- Soil
- Bulky waste including WEEE
- Garden Waste
- Hazardous waste (12-20 fractions)

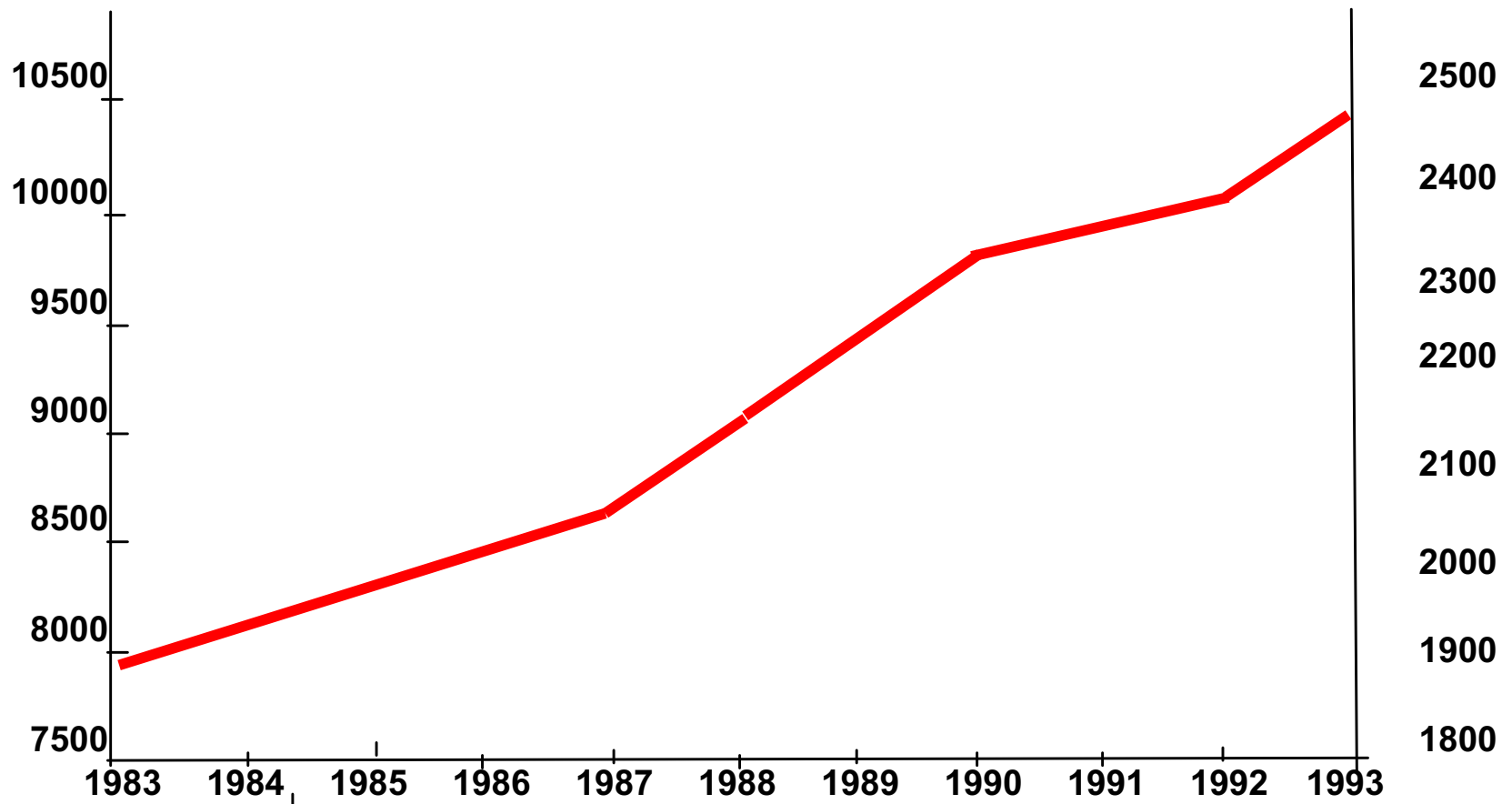




Managing Construction Waste-The Danish Experience

Development in Combustion Value

I/S VESTFORBRÆNDING 1983 - 93



Landfills



LANDFILL

New Policies:

- Only located at the coast on impermeable layer of clay
 - Municipal ownership
 - Ban on organic (combustible) waste on landfills
-

City of Copenhagen: Waste Collection Scheme for Households

3 levels of collection:

- Collection at the premises
- Collection in the Neighbourhood
- Collection in the District



National incentive systems

- Product taxes
(Disposable packaging, cutlery and dishes, plastic packaging)
 - Disposal taxes
(Incineration, landfilling)
 - Deposit/refund schemes
(bottles & cans, cars, Ni-Cd batteries)
 - Take-back systems
(tyres)
 - Voluntary agreements with business associations
-

Content of presentation



Options for MSW management

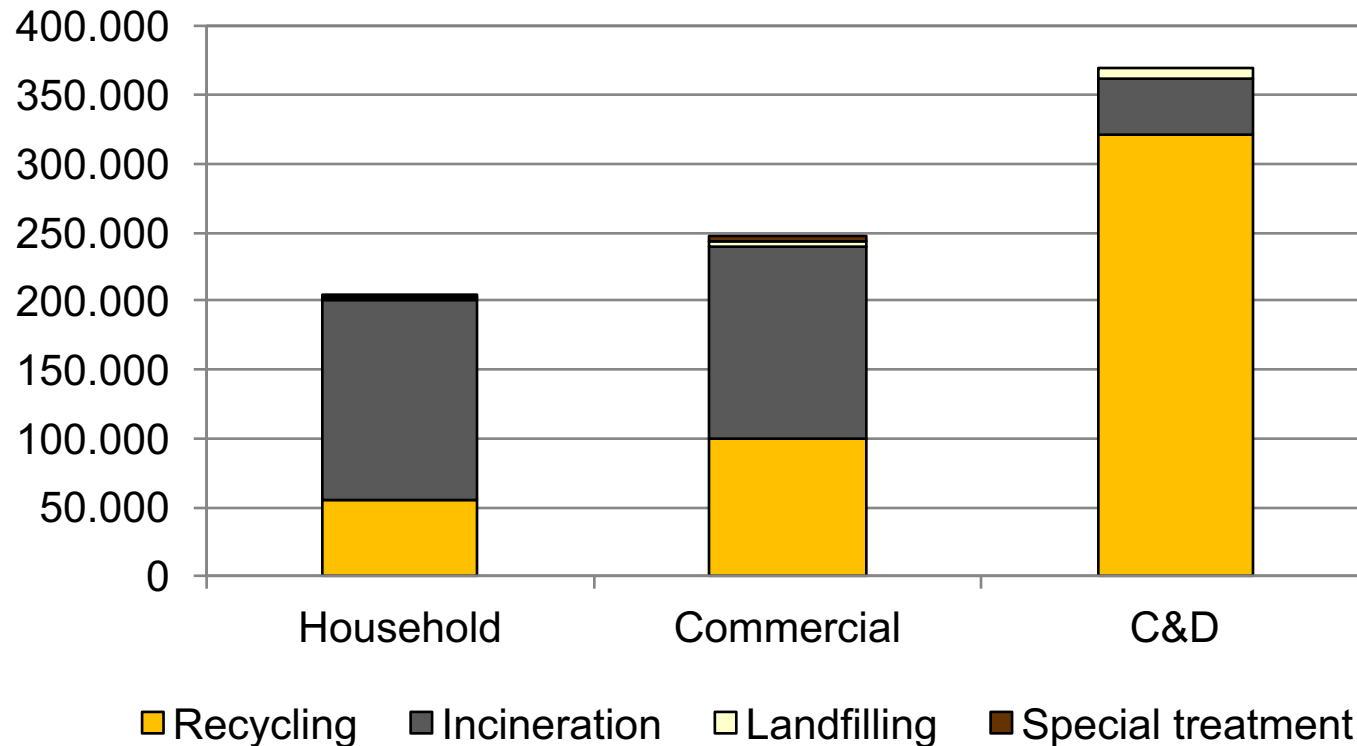
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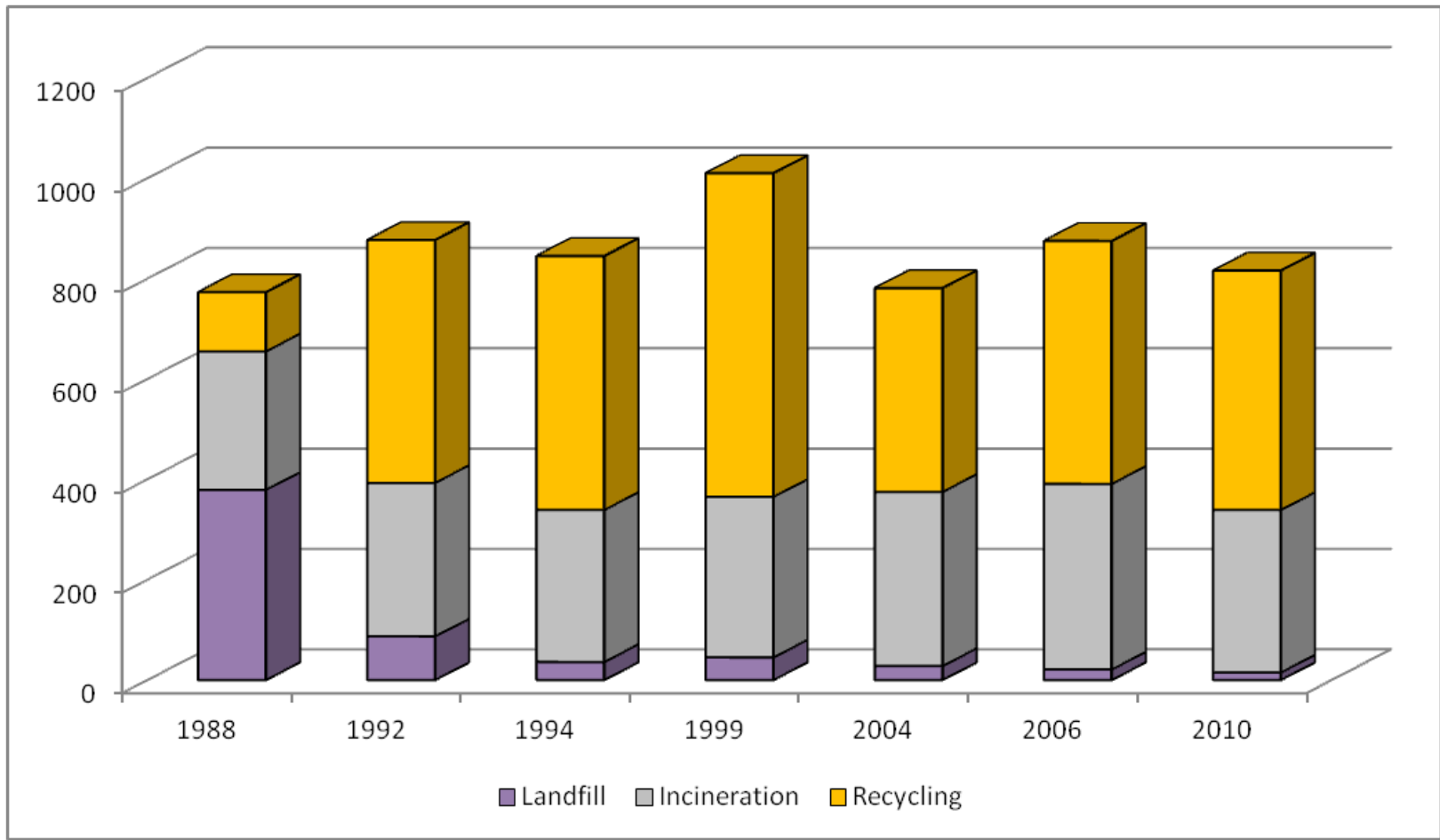
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Annual Waste Generation

- Total: 820,000 tons
- 2010: Recycling 58%, Incineration 39%, Landfilling 2%, Special treatment 1%



Waste distribution on treatment



Framework for for Danish Waste Management System

- **EU directives on waste management**
 - Waste planning and landfill diversion
 - WtE
 - Landfilling
- **National legislation on waste management**
 - Waste targets
 - Ban on landfilling of organic waste (1996)
 - WtE

Institutional arrangements

Waste processing

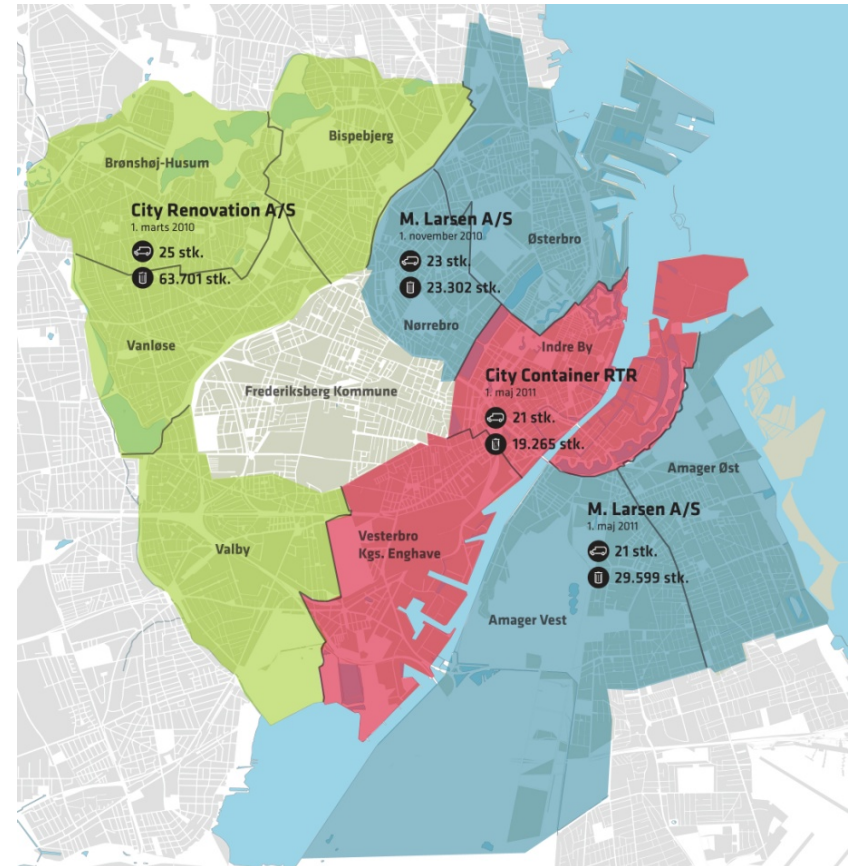
– 2 Intermunicipal Partnerships formed in 1965:

- **Amager Resource Center (ARC)** (5 municipalities)
- **Vestforbrænding** (19 municipalities)
 - Both Partnership operates WtE plants with power and heat generation
 - Both partnerships deliver heat to extensive district heating network
 - The partnerships operates a common landfill for non-recyclable residues
 - A partnership between all 24 municipalities operate a hazardous waste handling facility

Institutional arrangements

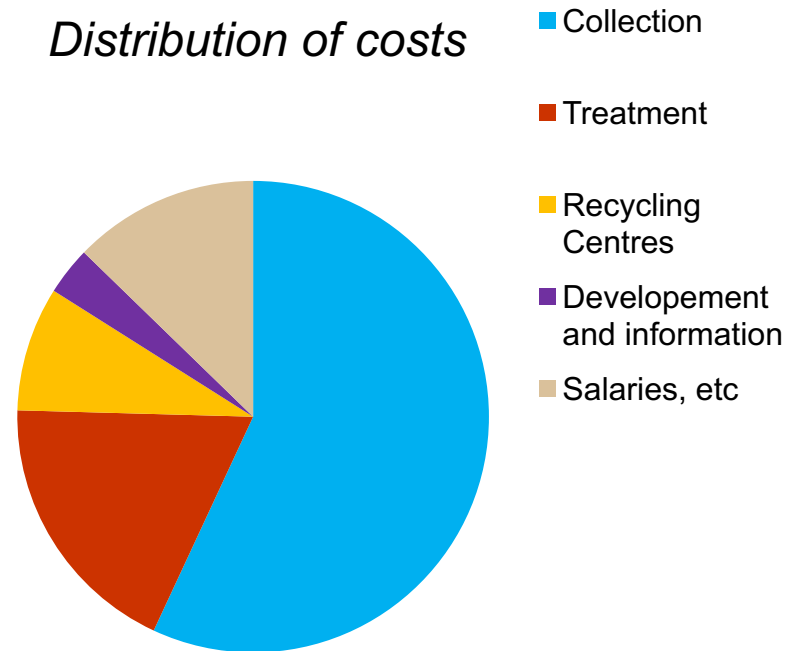
– Waste collection

- Managed by the city
- Tendered out, divided into 4 zones



Economy of waste management system

Distribution of costs



Costs and financing:

- Total waste fee per year: 526 mio DKK (75 mio €)
- Costs for households per year:

Costs in EUR	Total costs	costs for treatment
Single family houses	430	53
Flats	237	53

Waste collection - households

Flats: separate collection of:

Paper Card-board Rigid plastics Metal (Small) electronics Bulky waste Hazardous waste Residual waste Glass waste



Single-family houses: separate collection of:

- Rigid plastics & metal
- Small cardboard (voluntary)
- Organic / biowaste
- Paper
- PVC
- Impregnated wood
- Hazardous waste
- Glass waste (bring)
- Bulky waste
- Residual waste



Beirut 10. 10. 2016



Resource and Waste Management Plan 2018

Targets

- 20 % reduction in waste to incineration
- 45 % of household waste to recycling –
- Double recycling by 2018

- ~ Estimated costs:
300 mio DKK – 40 mio EUR



Resource and Waste Management Plan 2018 – Focus areas

- Waste prevention
 - Food waste, C&D waste, plastic and municipal procurement
- Biological treatment of food waste
 - 25.000 tons of food waste for biogas generation, nutrients spread on farmland
- Recycling of plastic waste
 - 15.000 tons of plastic diverted from incineration
- Copenhageners to sort better
 - Higher efficiency in recycling schemes
 - Attitude and behavioral change

Decision on new WtE plant at ARC made in 2012

Process has taken 3 years:

The most important issues have
been:

- *Optimizing capacity*
- *Financial issues*
- *Ensuring highest energy-efficiency and
highest standards for fluegas cleaning*



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Requirement for implementing WtE projects

- *All parties must be capable, committed and play their role*
 - National government
 - Standards for emissions
 - Requirements for establishing and operation of WtE plants
 - Monitoring and control
 - Responsible waste authority
 - Level of political and environmental ambitions
 - Requirements for tenders (construction and operations)
 - Requirements for contracting
 - Capacity to operate or to monitor operator
 - Owner of plant (if not authority)
 - High level of integrity (double bottom-line)
 - Monitoring of operator
 - Operator
 - Qualified and committed operations
-

Requirement for implementing WtE projects

- Plan for acquiring capacity and skills for *all* 4 parties must be established.
- Constructors and operators must be fully qualified and *MUST* meet equally qualified counterparts.



Thank you

