Waste Fired Power Plant

Designed for the Environment and Output

Waste-to-Energy Research and Technology Council
Columbia University

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On behalf of Dr. K. Daan van der Linde
Waste & Energy Company, City of Amsterdam
Waste & Energy Company Amsterdam

- Public Utility Company
- Owned by the City of Amsterdam
- 125 Years MSW management
- 87 Years W2E experience
- Operated on commercial basis
- Mission:
  - Lowest cost to the citizens
  - Optimal environmental performance
  - Maximum recycling, zero discharge
  - Home-grown R&D
4th Generation Waste Fired Power Plant (WFPP®)
Upon WFFP ® completion

- World’s largest and most efficient W2E facility
- MSW throughput > 1,500,000 MTPA
- WFPP® net electric efficiency > 30% (833 kWh/MT)
- Turnover > € 200 million
- Surplus ~ 10%
- Lowest tipping fees in the Netherlands; €70/MT
- Electricity generated >1,000,000 MWh/yr
- Avoided CO2; 600,000 MTPA (CFPP)
- Recycling rate> 99%
- Emissions < European and Dutch standards
Amsterdam Eco-port® ; AEB and neighbors
Amsterdam EcoPort®

- Ecological concept of the City of Amsterdam to maximize synergies between adjacent industries and neighboring residential areas
- Objectives: reduce re-use, recycle, BPEO
- Priorities are sustainability and the environment
- AEB is cornerstone in energy production and distribution and turning waste into products
- Other major participants:
  - Municipal sewage sludge facility
  - Windmill park
  - Municipal district heating facility
  - Steenkorrel BV, building materials
How did we accomplish this?

- Environmental responsibility
- Minimal nuisance
- Community relationship building
- Attractive architecture
- Efficient and economical operation
- Continuous improvement, in-house R&D
- Beneficial to the City, its residents and industry
- Dedicated and competent employees
Environment; stack gas emissions

- Toxic emissions < 10 garbage trucks
Environment; other

- Liquid discharge
  - Zero
- Solids discharge
  - Presently > 1 % of ash produced
  - AEB, concept to arrive a zero discharge
- Noise
  - Outdoor day > 200 meter < 55 dBA
  - Outdoor night > 200 meter < 45 dBA
Environment; other

- Odor
  - None appreciable; plant under negative pressure

- MSW delivery options:
  - Road
  - Rail
  - Water
Excellent community relations

- Working plant, No problems in the past
- Involve citizens and NGO’s
- Allowing sufficient permitting time
- Communicate in an understandable language
- Demonstrate benefits to City, citizens, industry
AEB architecture
Brecia
Vienna, Professor Hundertwasser
Hiroshima, Yoshio Taniguchi
Major patents and innovations

- Detergents in flue-gas cleaning for dioxins/furans reduction
- Salt factory for recycling residues from flue-gas cleaning
- Method and layout for reprocessing flue-gas residue
- Reheater concept for increasing the efficiency of W2E plants
- High-efficiency waste-to-energy plants.
- Flue-gas recirculation
- Use of bio-exhaust gas for improved drying and fuel efficiency
Improved design of steam superheaters

Linking a waste-to-energy plant to a waste-water purification plant

Method and layout for cleaning waste water.

Wet non-ferrous separation from bottom ash based on Magnus effect and density separation (three international patents in collaboration with Delft University of Technology).
Efficiency; steam reheating
Availability; Boiler design
Synergy: W2E & Sewage treatment

- **Municipal waste**
  - Sludge 100,000 MTPA
  - Biogas 25,000 m³/day

- **Waste water**

- **W2E**
  - Electricity 3 MW
  - Heat 50,000 GJ/yr

- **Sewage treatment plant**

- **Electricity**
  - To the national grid

- **Water**
  - To canal
Westpoort  400 TJ per year
Parkstad  1,300 TJ per year
Recycling; ash processing
Recycling; products / MT MSW

- Sand 85 kg → bricks
- Granulate 110 kg → concrete
- Iron 25 kg → trade
- Metals Non-Ferrous 5 kg → trade
- fly-ash 11 kg → filler in asphalt
- CaCl₂-salt 7 kg → industry, road
- Gypsum 5 kg → construction
- Residue (gas cleaning) 1 kg → disposal → vitrification
Recycling; non-ferrous metals
Recycling; lime stone bricks
Recycling; concrete
Recycling; metal recovery pays for itself

- **Metals**
  - 10% Ferrous Metals
  - 2.4% Non-ferrous Metals
  - Silver content; 10% Dutch consumption.
  - Copper content; higher than Chilean ore.

- **Minerals**
  - 35% Sand
  - 45% Granulate
Cost; size matters
WFPP® compared to other renewable options

Sources: EZ, Regeling subsidiebedragen milieukwaliteit elektriciteitsproductie; VROM, personal communication; ECN, 2002, Duurzame Energie en Ruimte, M. Menkveld; analysis Deloitte
WFPP® compared to other renewable options

And highest availability; Availability in %

**Availability (%) of time per year**

- Waste-to-energy
- Biomass
- Wind on sea
- Wind on land
- Sun

Sources: EZ, Regeling subsidiebedragen milieukwaliteit elektriciteitsproductie; VROM, personal communication; ECN, 2002, Duurzame Energie en Ruimte, M. Menkveld; analysis Deloitte
Recycling and W2E

Waste in the Netherlands

- blue: generated
- yellow: landfilled
- red: WTE
- green: recycled/other

kg/capita vs. year
US MSW landfill @ 130 million tons

- Electric power; >13,000 MW, 12 million homes
- Metals: > 4 million tons
- Construction materials: > 25 million tons
- Gypsum 650,000 tons
- Salt: 900,000 tons
WFPP® in US; potential avoidance and savings

- CO₂ avoided; ~ 6 Tg
- Methane avoided; 131 Tg CO₂ Eq.
- Leachate
- Oil saved: > 170 million barrels
- Gas, landfill trucking cut 50 miles:
  - Gas saved 25 million gallons
  - Toxicants avoided
Greenhouse effect

for MSW in USA (200 Million Ton/year)

Million Ton CO2/Year

Direct greenhouse emissions

Overall effect

Avoided Greenhouse effect

Avoided CO2 by energy production

Overall greenhouse effect

Methane (CO2-equiv.)

CO2 emission

CO2 used for biomass

Overall effect

Negative values indicate avoided greenhouse effects.
WFPP® in US potential; conclusion

- Safe, highest environmental standards
- Low nuisance factor
- Within city limits
- Virtually zero discharge
- Maximum solids recycling after combustion
- Economical operation; guestimated tipping fees
  - 6/700 thousand tons <$70/MT
  - 1.2/1.4 million tons <$40/MT
AEB services

- Technology transfer, licensing
  - Conceptual WFPP® design
  - Specifications and basic design of major equipment
  - Complete design for standard WFPP® facility

- Services
  - Facilities planning
  - Assistance in permitting procedures
  - Assistance in project realization
  - Management and operators training
  - Interactive operational support
  - Trouble shouting and de-bottlenecking services
City to City services

- (Pre) FEED studies
- Evaluation proposed technologies
- International post-graduate course; “Environment and Technology
- Support in formulation of legislation/permits
On behalf of
Dr. Daan van der Linde
and AEB
Thank You