

ECOSTILER – COGENERATION WITH BIOGAS IN THE DISTRICT HEATING SYSTEM OF AMSTERDAM, NETHERLANDS

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ABSTRACT

The City of Amsterdam Waste and Energy Company plays an important role in the realisation of the CO₂-reduction targets of the City of Amsterdam. This is done by producing heat for district heating and the production of electricity from sustainable fuels: biogas and Municipal Solid Waste (MSW). This paper focuses on the biogas activities which are part of the ECOSTILER project. It is described how biogas is used for district heating purposes and how district heating is being developed in Amsterdam.

AMSTERDAM CLIMATE POLICY

The City of Amsterdam has the ambitious plan to cut CO₂-emissions with 40% in 2025 in comparison to the emission level of 1990. In addition the municipal organisation aims to be climate neutral by 2015, with no CO₂ emissions or fully compensating them. To fulfil these ambitions a vast number of actions and measures have to be taken by the municipal organisation, the citizens of Amsterdam and by businesses in the Amsterdam area. Actions can include e.g.:

- Improvement of thermal isolation of houses and apartments. This will be done for new build housing but especially the refurbishment of housing estates built in the 1950's to 1970's;
- Use of (surplus) heat from industry in district heating;
- Promotion of energy efficient vehicles for the municipal organisations;
- Use of biomass for energy generation;
- Development of smart ICT solutions to decrease CO₂-emissions (in co-operation with Cisco and the cities of Seoul and San Francisco within the Clinton Global Initiative).

A major role in the development and execution of all these initiatives is played by the City of Amsterdam Waste and Energy Company (or Afval Energie Bedrijf, AEB, as it is called in Dutch).

CITY OF AMSTERDAM WASTE AND ENERGY COMPANY (AEB)

The Waste and Energy Company (AEB) is a City of Amsterdam public utility company. It operates as an independent business, but is an integral part of the municipal organisation of the City of Amsterdam. AEB is since 1993 situated in Amsterdam's western port district (see figure 1 for an aerial view). In this year AEB opened its new Waste to Energy plant. AEB activities expanded with the co-operation with the neighbouring municipal waste water treatment for biogas utilisation and sludge processing, and the start of operation of the new Waste Fired Power Plant (WFPP). Some of the key figures for 2006 and 2007 are given in table 1.

Table 1. Key figures of AEB 2006 and forecast 207

(note that the Waste Fired Power Plant will be operational in the second half of 2007)

		2006	2007
Turnover	€	114,340,000	151,950,000
Employees		300	306
Waste treated (including sewage sludge)	Tons	943,224	1,127,000
Electricity from waste	MWh	540,543	672,000
Heat from waste (incl. biogas)	GJ	215,546	250,000
Biogas utilization	Nm ³	5.487,015	9,125,000
Electricity from biogas	MWh	14,936	25,000

CO-GENERATION AT AEB

The main activity of AEB is to generate energy from Municipal Solid Waste (MSW). This is done by incineration of MSW to produce heat for district heating and electricity production. Furthermore heat and electricity is produced by using biogas from the municipal waste water treatment plant as a fuel for four Combined Heat and Power (CHP) engines. Although waste incineration and biogas utilization both deal with co-generation, the WtE activities will only be discussed briefly. Focus will be on the biogas utilization because these activities are part of the ECOSTILLER project.



Figure 1. Aerial view of AEB. The left stack is the new Waste Fired Power Plant, the right stack is the existing Waste to Energy plant, the sludge digesters from the municipal waste water treatment can be seen in the forefront.

WASTE TO ENERGY PLANT (WTE PLANT)

The Waste to Energy (WtE) plant has a net electrical efficiency of more than 25%. Thanks to an effective approach to reduce discharge of dioxins and other toxic substances, it was in 1993 the first new built plant in the Netherlands to comply with the then new emission regulations. Today the existing plant processes some 850,000 tonnes of urban waste and 100,000 tonnes of sewage sludge each year. And next to 150,000 GJ district heating, it delivers 530,000 MWh of electricity to the national grid annually.

WASTE FIRED POWER PLANT (WFPP)

The starting point for the development of the Waste Fired Power Plant (WFPP) was the sense that waste to energy is more than only a clean solution to get rid of waste. The conventional WtE should be adapted to maximizing the recovery of energy and materials. This led to the development of the fourth generation WtE that is 'designed for output'. The result is the new Waste Fired Power Plant achieving a 30% net electrical installation efficiency. Bottom ash will be washed to produce clean

sand and aggregate and to maximize recovery of metals. From fall 2007, the existing WtE plant and the WFPP operate in parallel, both under the name of AEB. Their total processing capacity is 1.5 million tons of waste and sewage sludge per year.

European co-operation at AEB

As an innovating company AEB co-operates with various organisations in European or nationally funded projects. The purpose of these projects is to develop and demonstrate new technologies, also within the framework of Amsterdam's climate change ambitions. Some examples are:

- LIFE project to demonstrate the recovery of metals, and the production of building materials from bottom ash (LIFE);
- NextGenBioWaste, innovative demonstrations for the next generation of biomass and waste combustion plants for energy recovery and renewable electricity production (FP6);
- Ecostiler, Energy efficient COmmunity STimulation by use and Integration of Local Energy Resources (FP6);
- High Energy Recovery, demonstration of the WFFP (FP6)
- Utilisation of surplus heat in Amsterdam North (Dutch funded)
- Training and dissemination network for Waste to Energy (in preparation, IEE)

ECOSTILER

'Energy efficient COmmunity STimulation by use and Integration of Local Energy Resources', is all about a co-ordinated approach for achieving energy efficient communities. The common and essential element of the project involves the use of bio-gas and district heating systems. They act as tools in the reduction of primary fuel consumption and CO₂ emission. ECOSTILER's approach embraces communities from London (UK), Mårbjerg (DK) and Amsterdam (NL), of different sizes, ranging from small to large, from urban to rural, making it a valuable demonstration project in the CONCERTO initiative. ECOSTILER is supported by the CONCERTO programme, funded by the European Unions's 6th framework research programme.

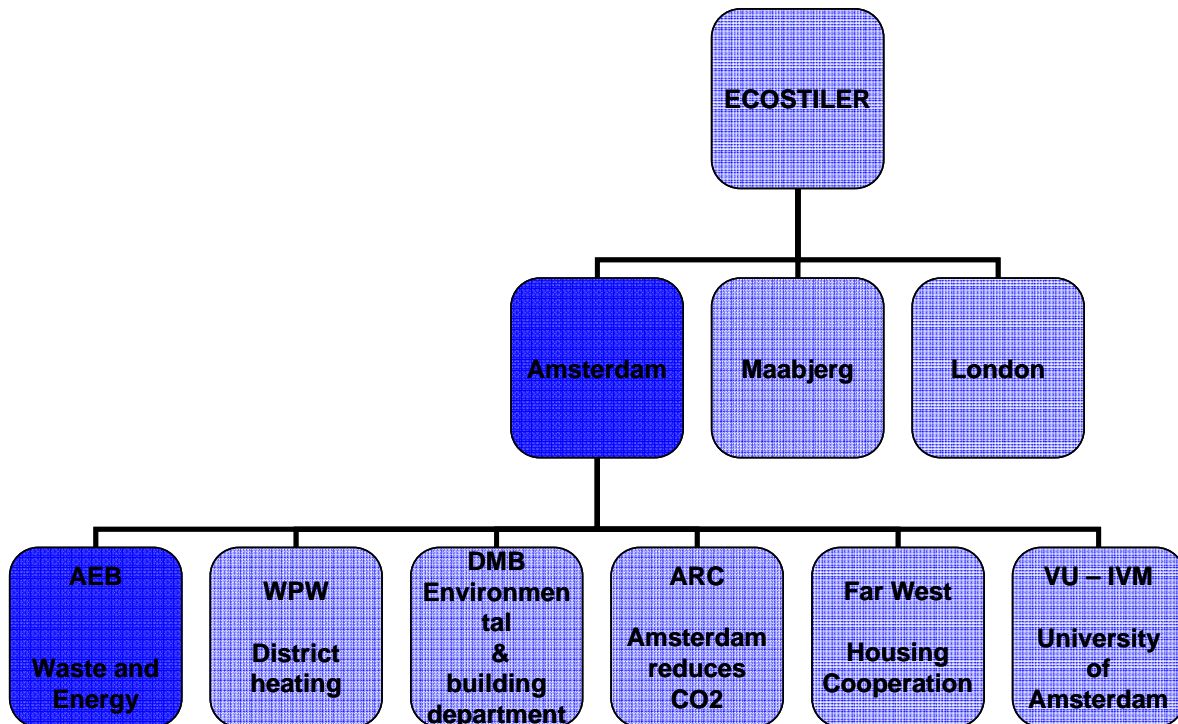


Figure 2. Amsterdam partners in ECOSTILER

Main activities of ECOSTILER in Amsterdam are:

- Renewable energy supply (RES) in Amsterdam New West, mainly by CHP from biogas. By locating the new sewage plant next to the waste-to-energy plant, several mutual benefits are available. The Waste to Energy plant provides electricity and heat to the sewage plant. In return, the sewage plant digests sewage sludge and provides biogas that produces additional electricity and heat in the WtE plant. This synergy leads to an increase of the energy efficiency of the biogas CHP from 50% to over 90%.
- Energy efficiency in buildings (RUE). The housing corporation Far West in Amsterdam New West have committed themselves to a building standard that goes significantly beyond legal requirements. Within ECOSTILER, about 300 dwellings from the 1960's will be refurbished with a special emphasis on energy efficiency. Measures include isolated glazing, rigorous shell improvement and isolation, upgrading of heating system and domestic hot water supply (figs 3 and 4).



Figures 3 and 4. Energy efficiency in buildings. Refurbishment of the 'blok 40' apartment blocks by housing corporation Far West

- Polygeneration. ECOSTILER marks the start of the realization of an impressive district heating system. This system is developed within the existing neighbourhood of about 50,000 dwellings. When completed, it accounts for about half of the challenging 50% CO₂ reduction ambition of New West upon completion. (WPW)
- Socio-economic research to monitor the project in achieving technical, social and environmental objectives. (VU-IVM)
- Dissemination of project results and energy saving options to the general public and professional parties. (DMB and ARC)

CO-GENERATION FROM BIOGAS

A traditional biogas plant within a sewage treatment plant has an electrical energy efficiency of about 40%. When used in a CHP configuration (which is not very common) there is an additional thermal heat efficiency of 42%. This means a total energy efficiency of about 82%. The AEB –biogas recovery plant will have a total energy efficiency of about 94%. This is achieved by combining CHP, WtE, and

Waste Water Treatment (WWT). The biogas is produced in the adjacent WWT (figure 5).

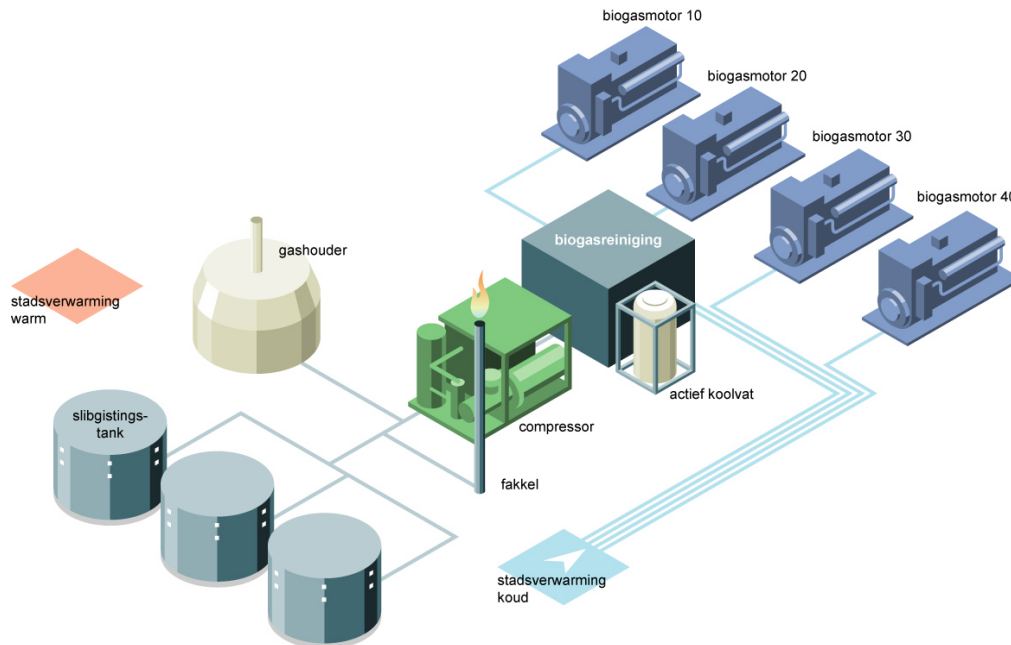


Figure 5. Biogas from the adjacent WWT

AEB's biogas energy recovery plant will have the following energy outputs:

- Electricity produced by four gas engines-generators with an electrical efficiency of 40%.
- Heat produced from the cooling water of the gas engines with a thermal efficiency of 38% and,
- Use of the hot flue gases of the gas engines as incinerator air for the waste fired power plants with a heat efficiency of 16%. Due to the higher temperature of this incineration air the electrical energy efficiency of the WtE plant will increase (figure 6).

Exhaust gas system

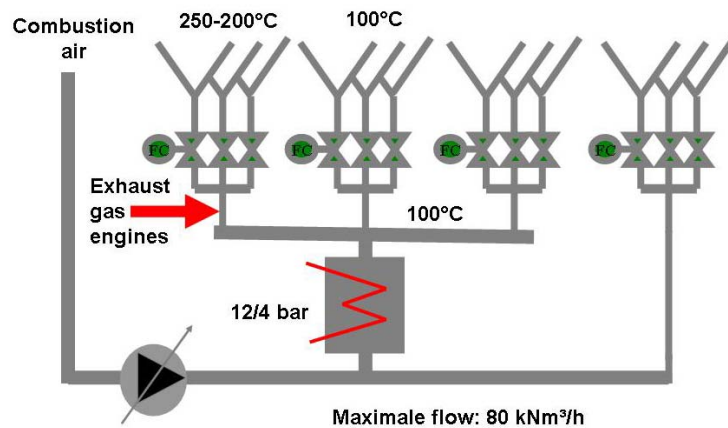


Figure 6. Use of flue gases in the WtE plant

DISTRICT HEATING IN AMSTERDAM

District heating is one of the most promising opportunities to reduce CO₂-emissions significantly. This is why the City of Amsterdam is investing in the development and the extension of the district heating grid and the implementation of new connections. Amsterdam is directly participating, through AEB, in Westpoort Warmte (WPW). WPW is a joint venture with the energy company Nuon. An overview of the district heating potential for Amsterdam in the future is given in figure 7. The stars are the Combined Heat Power stations in Amsterdam, the light green area's are the areas where district heating is developed at the moment.



Figure 7. District heating in Amsterdam