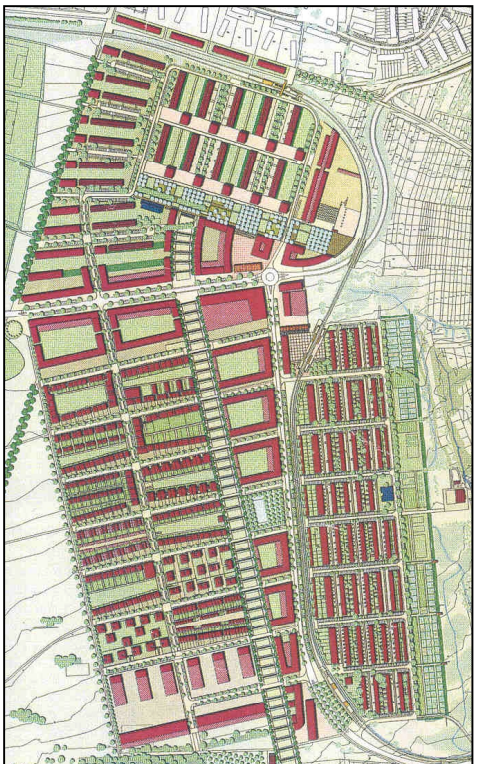
Background information for the paper Moerschner, Maier, Schmidt

1 General aim of the project "Scharnhauser Park"

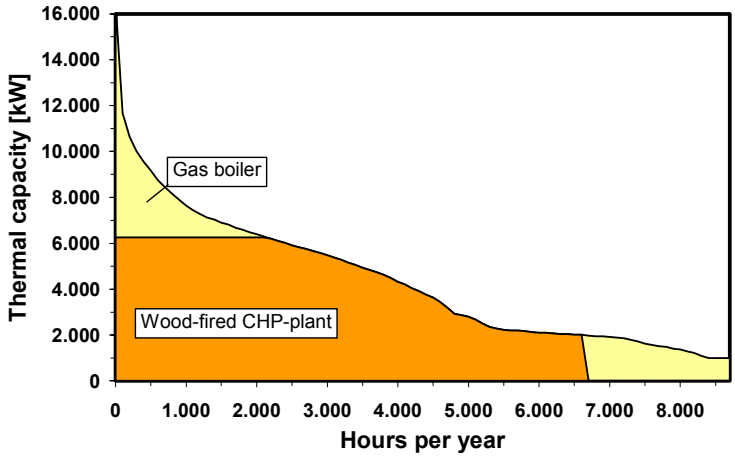
The municipal services of Esslingen, the municipality of Ostfildern and the contracting company KWA from Bietigheim-Bissingen have founded a company which is installing a wood-fired CHP-plant for the heat supply of the development area "Scharnhauser Park" in Ostfildern near Stuttgart, Germany, under the overall control of the municipal services Esslingen. Commissioning of the plant will presumably be during the first quarter of 2004.

For power generation - a production of more than four and a half million kilowatt-hours is planned - the so called ORC-cycle is used.

More than 80 percent of the 35 million kilowatt-hours of district heating are obtained from wood chips which are a local energy carrier. Hence, three and a half million cubic meters of natural gas can be saved. Overall 10.000 tons of carbon-dioxide can be avoided.



Development area "Scharnhauser Park"



Heat demand of the development area

2 Technical concept

In addition to the existing gas-fired heating plant owned by the municipal services of Esslingen a new CHP-plant is installed, consisting of a wood-fired boiler with a thermal capacity of 6.000 kW and a power generation module including the necessary peripheral units.

For power generation an ORC-module (Organic-Rankine-Cycle) with an electric capacity of 1.000 kW is used.

The used wood boiler possesses a grate furnace. Thanks to the integrated pre-drying fresh wood chips can be burned.

For flue gas cleaning a dust collector (cyclone) is installed downstream the furnace to separate dust particles escaping with the flue gas out of the combustion chamber. The cyclone is followed by an electrostatic precipitator securing a maximum portion of dust of 20 milligrams in the

Delivery of an ORC-modul

flue gas.

The CHP-plant shall be fuelled mainly with wood chips from landscape conservation measures and a percentage of about 25 % of wood from forestry.

One advantage of the ORC-cycle used for power generation is that no high pressures are required in contrast to the conventional steam-cycle. Consequently, operation- and personnel costs are relatively low. Besides ORC-modules have a high partial load effect benefiting an operation with thermal load priority. A further advantage of ORC-systems is the fact that they are delivered on site completely assembled in contrast to steam engines or steam turbines.

The described CHP-plant reaches a high overall effect. About 80 percent of the energy contained in the wood are converted into heat and electric power. Thus, the CHP-plant differs from many biomass plants installed lately in Germany which are erected for the purpose of power generation only.

3 Public grants

Because of its innovative character the project is supported with an amount of 488.000 € by the Ministry of Trade and Commerce of Baden-Württemberg. The agricultural department of Baden-Württemberg contributes 250.000 € as well.

4 Economic concept

The overall investment for the CHP-plant sums up to 5,2 million Euro.

	Investment €
Furnace	2.120.000
Power generation unit	1.607.000
Building and development of the building site	925.000
Additional cost	550.000
Overall investment	5.202.000

The annual financial expenses consist of capital cost, operation cost and fuel cost.

These expenses face revenues for power generation and avoided costs for substituted natural gas. Revenues for power generation arise from feeding into the grid and reimbursement to fixed tariffs according to the German EEG (Renewable energy source act).

5 Energy balance for the ORC 1000 kW_{el} solution

At full district heating capacity, prospectively reached in the year 2008, and operation with thermal load priority, fuel insert and energy output of the CHP-plant will be as presented below.

Usable Heat	30.590 MWh/a
Gross power generation	4.610 MWh/a
Insert of wood chips	43.550 MWh/a
	62.210 m^3/a
Electric effect	10,6 %
Thermal effect	70,2 %
Overall effect	80,8 %

With an amount of 38.240 MWh/a of natural gas avoided, the saving of carbon-dioxide emissions adds up to about 10.000 tons per year.

6 Characterisation of alternative options for the "Scharnhauser Park" project and their costs

Characteristics of the biomass furnaces (along /Kohlbach 2002b/)

		ORC 700 kW_{el}	ORC 1000 kW_{el}	Steam motor 700 kW_{el}	Steam motor 1000 kW_{el}	Steam turbine
Combustion capacity	[kW_{th}]	6.550	8.770	5.600	8.400	9.000
Thermal capacity [1]	[kW_{th}]	5.750	7.670	4.800	7.200	7.700
Thereof eco-capacity [2]	[kW_{th}]	1.250	1.670	880	1.320	1.410
Max. steam flow rate [3]	[kg/h]	--	--	6.350	9.520	10.040
Min. therm. rate	[%]	30	30	30	30	30
Annual effectiveness	[%]	82,5	82,5	82,5	82,5	82,5

[1] incl. economiser

[2] ORC-process: Hot water economiser

[3] corresponding to the fresh steam and exhaust steam parameters of the power

Systems effectiveness

		ORC 700 kW_{el}	ORC 1000 kW_{el}	Steam motor 700 kW_{el}	Steam motor 1000 kW_{el}	Steam turbine[1]
Electric effectiveness	[%]	10,8	11,6	12,8	12,9	12,1 / 16,6
Thermal effectiveness	[%]	73,8	73,3	70,6	71,0	65,8 / 18,4
Overall effectiveness	[%]	84,6	84,9	83,4	83,9	77,9 / 35,0

[1] left: at maximal extraction / right: at maximal power

Capital costs, in €

	ORC 700 kW_{el}	ORC 1000 kW_{el}	Steam motor 700 kW_{el}	Steam motor 1000 kW_{el}	Steam turbine
Grate furnace	1.895.000	2.120.000	2.120.000	2.565.000	2.685.000
Power conversion unit	1.330.000	1.540.000	713.000	847.000	1.245.000
Cooling unit	75.000	100.000	60.000	95.000	--
Buildings,	853.000	853.000	853.000	853.000	853.000
Misc. costs	489.000	542.000	442.000	512.000	574.000
Overall capital costs	4.606.000	5.122.000	4.150.000	4.839.000	5.357.000