

The Swedish Enköping CHP plant

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1. ABSTRACT

The district heating system in Enköping has connected all mayor buildings in the town and also most of the single-family houses. Enköping have about 20000 inhabitants and is the most central town in Sweden. In 1994 a CHP plant was commissioned on bio energy and in 1997 an oil-fired boiler was converted to wood powder. Since then all electricity and all heat produced are based on bio energy. Because Enköping is situated in the most dense part of Sweden the region consume more bio energy than that comes from forest residuals in the region. The risk for high prices on bio energy is obvious and we started to look at possibilities of increasing the short rotation forestry. Today we use between 15-20 % of our yearly consumption from Salix that is grown in the neighborhood. While developing these short rotation forestry plantations we have reached interesting experiances.

2. BACKGROUND

Enköping is a Swedish town situated in the densest part. One third of the Swedish population is living within 100 km distance from Enköping. The region has about 46 % farming land and about 37 % forests. If the region in the long run shall be using forest residuals, we must use to the region imported bio fuel. Enköping was up to ten years ago mainly having industry that gave the people employment in the town. Today this industry is very small so the possibilities for waste heat into the district heating system from the industry is becoming smaller and smaller. Nearly all buildings in the town are using district heating. The district heating system was built between 1970-1978. The production of district heating is from 1997 only based on bio energy. From 1995 85% of the district heating is produced in Combined Heat and Power where mainly forest residuals are used as fuel but an increasing part is fuel from short rotation forestry.

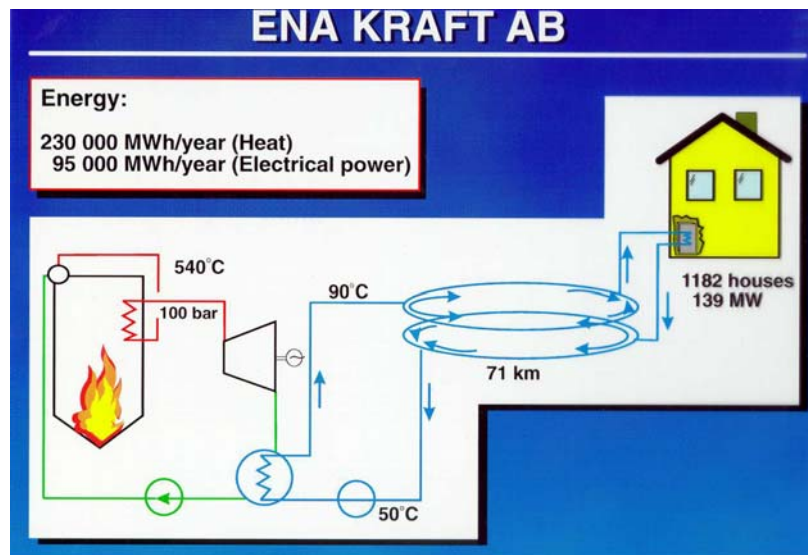


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3. ENKÖPING CHP PLANT

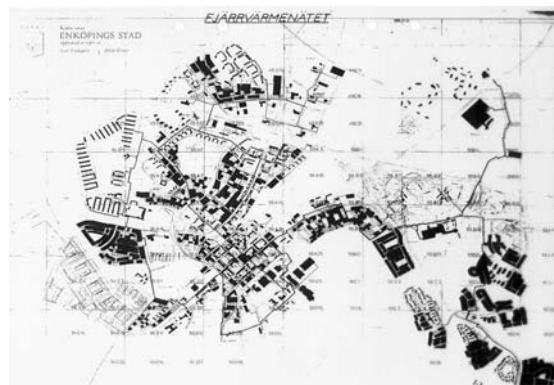
3.1 General

In the beginning of 1990 the Swedish government had put taxation on carbon dioxide emitted from fossil fuel combustion. The driving force to convert district heating boilers to bioenergy was there. In 1992 there was decided that a subsidy of 4000 SEK/kW was given if somebody built electric production from biofuels. At this time the company owned by the municipality decided to invest in a CHP plant with the capacity of 45 MW of heat and 24MW of gross electricity. During 1994 the CHP was erected and commissioned and have since then operated more than 40,000 hours. Because of the summers the operating time is approx. 5,500 hours per year. The steam cycle is conventional, natural circulation, single superheater cycle. The combustion is done in a vibrating grate boiler where the fuel is fed by spreader stoker.



3.2 District heating

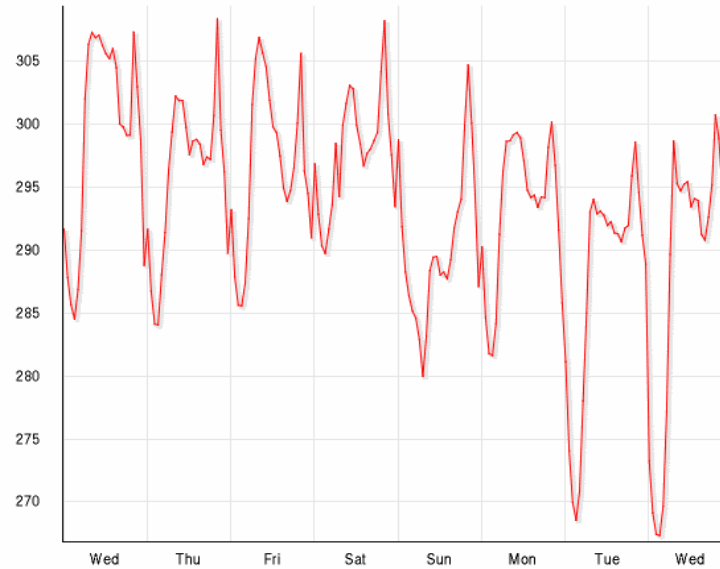
The district heating system is covering all the town. The company is supplying hot water at about 90°C and the costumers are cooling down this water to about 50°C. Totally 75 km of pipes is dogged down in the streets of Enköping. The CHP plant is supplying about 85% of the heat demand in the town.



3.3 Electricity

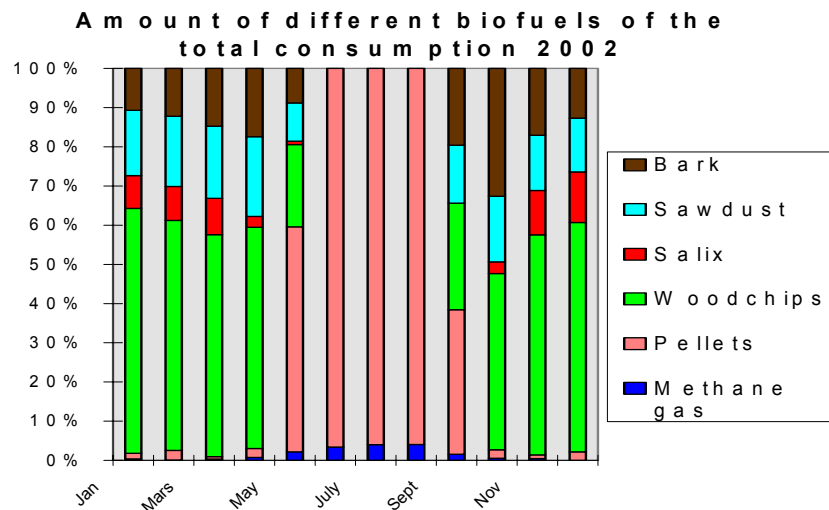
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The electricity produced in the CHP plant is sold on the nordpool market place. This market place is centralized for four different countries and the value of electricity is varying every hour. We give an offer to the market at 09.00 every morning and we know at 15.00 hours if the market will buy the electricity for the next day.



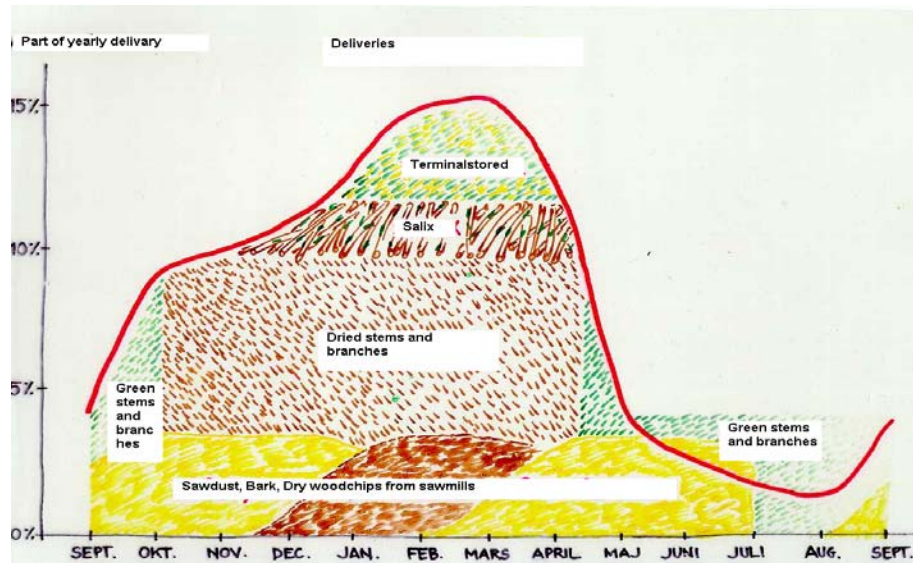
3.4 Fuel supply

Normally the CHP plant annually consumes about 400000 m³ chips from forest residuals and SRC. When the flue gas condenser is not used the fuel consumption increases to about 450,000 m³ of woodchips. The normal supply is shown in the figure below.



To be able to fulfill the fuel supply the delivering company is planning according to the figure below.

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3.5 Experiences

The experiences from operation and maintenance of the CHP plant during the first ten years is very good. We normally reach an availability at 99%. The efficiency with flue gas cooler in operation is near 100% and without the cooler it is around 90%. There is no significant difference in performance compared to coal firing. The investment cost is higher because of the volume of the fuel but the ash handling costs are much smaller. The key figures for operation is shown in the figures below.

Nyckeltalssammanställning för ENA Kraft AB								
Tillgänglighet	1995	1996	1997	1998	1999	2000	2001	2002
Kalendertid			8 760	8 760	8 760	8 760	8 760	8 760
Reservtid			3 109	2 945	3 173	2 884	3 060	3 060
Total önskad drifttid			5 651	5 815	5 587	5 782	5 700	5 700
Drifttid elproduktion			5 635	5 722	5 551	5 646	5 656	5 651
Drifttid el- eller värmeproduktion			5 636	5 744	5 573	5 665	5 671	5 651
Drifttid med bibränsle			5 466	5 710	5 567	5 659	5 662	5 651
Tillgänglighet elproduktion			0,997	0,984	0,994	0,976	0,992	0,991
Tillgänglighet produktion			0,997	0,988	0,997	0,980	0,995	0,991
Tillgänglighet bibränsle			0,967	0,982	0,996	0,979	0,993	0,991
Produktion								
Värme	191 555	205 105	201 787	205 272	196 841	177 540	198 675	201 825
El brutto	68 837	72 634	74 295	72 203	50 315	33 527	67 118	83 274
El netto	62 779	66 273	67 735	65 654	45 426	29 215	59 602	75 349
Summa brutto	260 392	277 739	276 082	277 475	247 156	211 067	265 793	285 099
Summa netto	254 334	271 378	269 522	270 926	242 267	206 755	258 277	277 174
Konsumtion								
Bio	271 217	286 167	280 974	276 400	244 825	209 860	264 076	308 148
Gasol	2 198	3 824	2 559	1 036	1 098	2 611	597	378
Eldningsolja	58	11	135	0	0	0	0	2
Summa	273 473	290 002	283 668	277 436	245 923	212 471	264 673	308 528
Godhetstal								
Totalverkningsgrad ne	0,930	0,936	0,950	0,977	0,985	0,973	0,976	0,898
Totalverkningsgrad br	0,952	0,958	0,973	1,000	1,005	0,993	1,004	0,924
Alfavarde brutto	0,359	0,354	0,368	0,352	0,256	0,189	0,338	0,413
Alfavarde netto	0,328	0,323	0,336	0,320	0,231	0,165	0,300	0,373
Fjärrvärmeförbrukning	0,780	0,788	0,860	0,834	0,858	0,826	0,843	0,853
Försäljning								
Fjärrvärmeförsäljning	223 373	234 393	209 498	217 778	201 783	197 806	211 501	212 722