1st World Conference on Biomass for Energy and Industry, Sevilla, Spain, 5–9 June 2000
Pages 406–408.

Processes for Storage and Energetic Use of Cotton Plant Residues

M. Gaderer , Th. Fischer, P. Lamp
Bavarian Center for Applied Energy Research (ZAE),
Division Solar Thermal and Biomass, Domagkstr. 11, D-80807 München, Tel.: ++49-89-356250-27, Fax: -23
E-mail: gaderer@a4.zae.physik.tu-muenchen.de, Internet: http://www.zae-bayern.de

1. SUMMERY AND FRAMEWORK OF THE COBER PROJECT

Within the EU project COBER[1] (Cotton Biomass Energy Recovery), Greek, Austrian and German partners are investigating in a feasibility study the perspectives of an energetic use of residues from cotton farming situated in Karditsa, central Greece. The work is funded as part of the Non Nuclear Energy RTD Programme as a pilot project concerning this specific biofuel. The scope of tasks ranges from the harvesting procedure, the biomass logistics and conversion processes for specific end users up to the environmental impact of suggested power plants. The part of the ZAE, which is presented here, focuses on the conversion processes.

A survey of the contributions of the different partners can be found in Table 1.

Project Partners: DG-XII JOULE PROGRAM / JOR3-CT98-0309

Research Institutes:
- ZAE-Bayern Division 4 Solar Thermal and Biomass
- TU-Munich, Institute Thermal Power Systems
- National Technical University of Athens
- University of Athens

Industrial Partners:
- IFB Dr. Braschel GmbH
- Austro Control KEG
- ARVIS Ltd.
- Technolin S.A.
- Kafantaris Papakostas S.A.

Table 1: Project partners and contributions to the COBER project

As a part of the project several scenarios concerning the energetic use of cotton plant residues in Greece have been investigated. By the lack of sufficient large thermal consumers in the considered area of Karditsa, the production of electricity or of cotton plant pellets as a high quality biofuel are proposed. Suggested combined heat and power plant sizes are ranging from 1 to 20 MW_{el} with or without an affiliated pellets production. An economic analysis shows, that under the given boundary conditions with comparably low energy prices and revenues, none of these larger scenarios based on actual heat demands could reach rentability. Thus, only smaller applications without production of electricity are found to be actually economical like the heat supply for an existing hospital or the production of pellets, under the premiss, that an adequate market of small distributed users would evolve.

A more detailed description of the whole project can be found at: ttp://simor.mech.ntua.gr/thecober/coberbasic.htm

2. IMPLICATION OF THE BIOFUEL ON THE CONVERSION PROCESS

Compared to wood chips, for the cotton plant biomass a more detailed planning of harvest, storage and conservation is necessary. Concepts of drying and of silage with respect to the energetic output and the resulting costs were investigated. Drying increases the lower heating value of the biomass, but enormous installations would be needed for sufficiently fast processing in the rainy winter period. Following our calculations, a silage in combination with wet bale wrapping would be the most economic solution. Also, the characteristic elementary composition of the cotton plants differs from that of wood: The sulphur, nitrogen, chlorine and ash contents are by a factor of more than 3 higher, which affects several steps of the process chain, including the choice of the combustion system, which has been done by one of the project partners, the Chair of Thermal Power Systems from TU München.
Only a few drying or ensilaging experiments with cotton plants have been published in the literature. Therefore we try to estimate the expected losses by comparison with similar biomass material. Figure shows data from experiments with a mixture of grasses[2]

[1] Contract number JOR3-CT98-0309

[2] . Lingvall, P. and Lättemäe, P.; J. Sci. Food Agric., 79, 257-264 (1999)

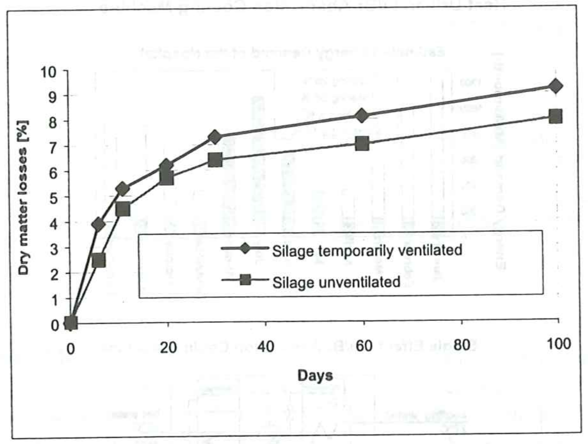

Figure 1: Dry matter losses of a mixture of grasses in a silage experiment.

For cotton plants with a starting water content of 50% we expect a dry matter loss of 4 to 7 % . With degradation concerning mainly plant substances of high energy content, the decrease of the lower heating value can be estimated at 6 to 11 % during half a year.

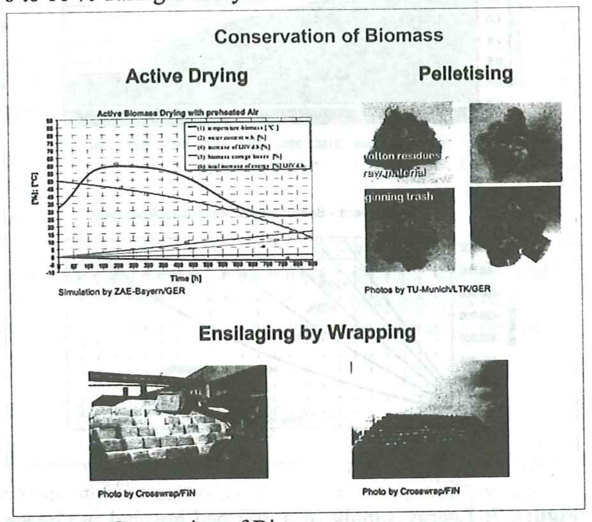

Figure 2: Conversion of Biomass

3. CHARACTERISTICS OF THE ENERGY DEMAND

The region of Karditsa shows a low density of population and industry, that is a low demand of energy, especially heat in the neighbourhood of possible power plant sites. The technical potential of the residues from an area of roughly 40 km x 40 km amounts to 790,000 MWh/a, which is by a factor of more than 10 above the combined demand of electricity, heating oil and gas of the 20 largest local users. The prices of energy are comparably low in Greece, including the revenues for selling electricity from renewable sources of 61.4 Euro/MWh.

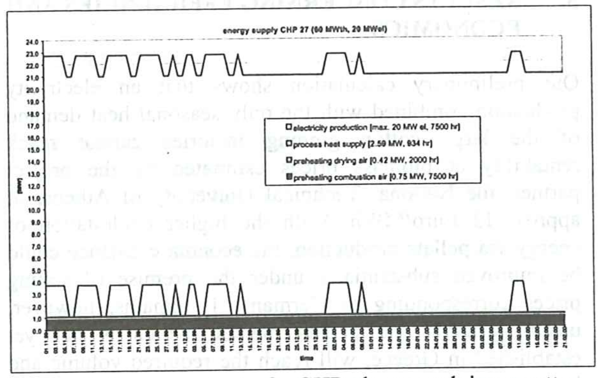

Figure 3: Energy output of a CHP plant supplying a cotton ginning factory with process heat

4. PROPOSED TECHNICAL CONCEPTS

Based on the quoted conditions the following scenarios are proposed: production of electricity in one larger (20 MW_{el}) or several smaller (5 MW_{el}) combined heat and power plants with moving grate and fluidised bed firing and tapped condensing turbines and ORC-turbines for flexible serving of a developing heat demand. Additionally or alternatively a production of biomass pellets is considered as well the energy supply of a hospital with heat for heating and cooling demand using an absorption cooling machine.

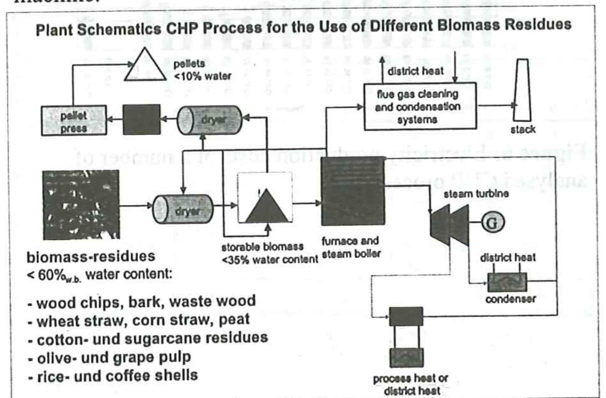

Figure 4: Plant schematics CHP process for the use of different biomass residues.

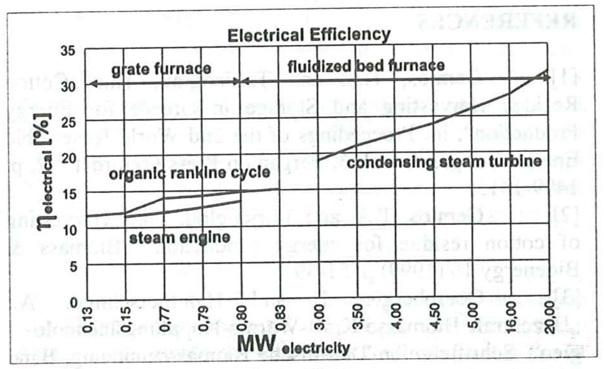

Figure 5: Possible electrical efficiency.

5. RESULTS CONCERNING EFFICIENCIES AND ECONOMICS

Our preliminary calculation shows that an electricity production combined with the only seasonal heat demand of the large cotton ginning factories cannot reach rentability at biomass prices estimated by the project partner, the National Technical University of Athens, of approx. 13 Euro/MWh. With the higher exploitation of energy via pellets production, the economic balance could be improved substantially under the premise of selling prices corresponding to Germany. It remains, however, unsure whether the pellets market, which is not yet established in Greece, will reach the required volume and level. Without an increase of revenues from electricity via CO_2 taxation or a general increase of energy prices the economic situation will probably remain too hard in most cases for possible investors. The energy supply of a hospital for heating and cooling applications could be an interesting economical solution.

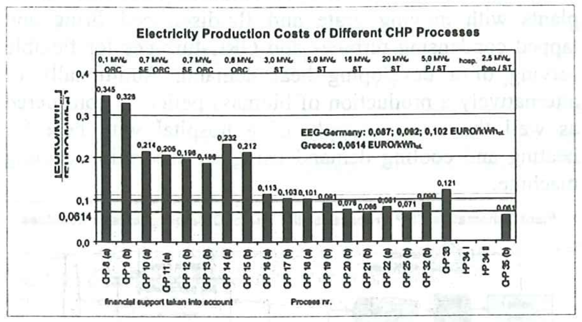

Figure 6: Electricity production costs of a number of analysed CHP processes.

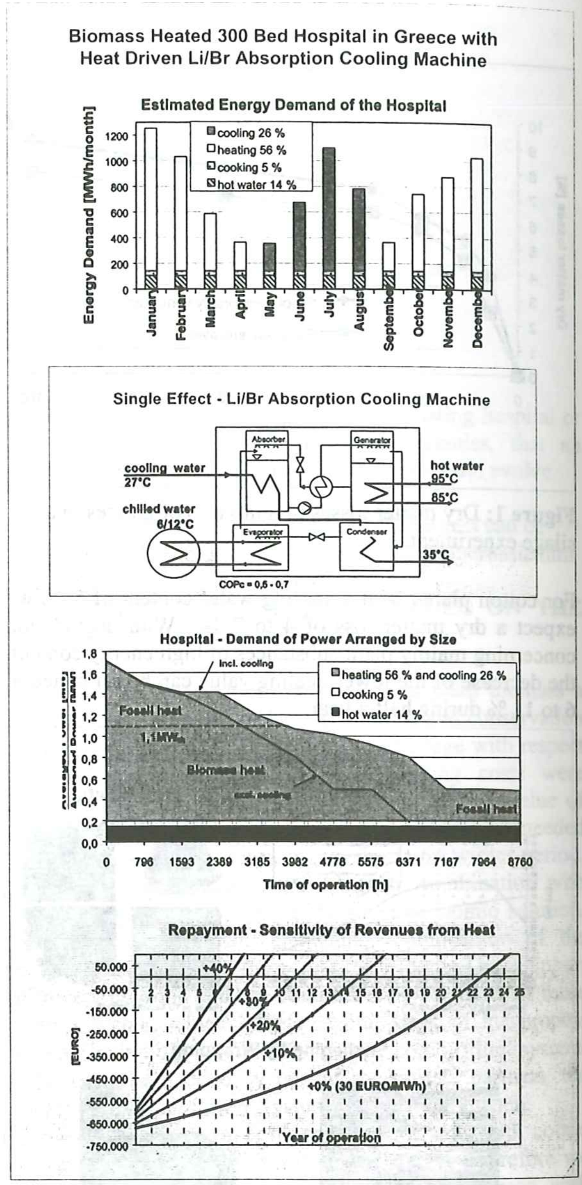

Figure 7: Energy supply of a 300 bed hospital in Greece with heating, cooking and cooling.

REFERENCES

[1] Gemtos, T.A. and Tsiricoglou, Th.: „Cotton Residue Harvesting and Storage in Greece for Energy Production“, in: Proceedings of the 2nd World Renewable Energy Congress, Vol. 3, Pergamon Press Oxford 1992, p. 1409-1413.

[2] Gemtos, T.A. and Tsiricoglou, Th.: „Harvesting of cotton residue for energy production“, Biomass & Bioenergy 16 (1999) p. 51-59

[3] Obernberger, I. and Hammerschmid, A.: „Dezentrale Biomasse-Kraft-Wärme-Kopplungstechnologien“, Schriftenreihe Thermische Biomasssenutzung, Band 4, dbv-Verlag, Graz 1999

[4] Schmidt, W.; Dietl, R.: „Mitverbrennung von Biomasse in einem Braunkohlekraftwerk der Bayernwerk Aktiengesellschaft“, in: „6. Symposium Im Kreislauf der Natur – Naturstoffe für die moderne Gesellschaft“, C.A.R.M.E.N. e.V., Rimpar near Würzburg, 1997, p. 23-36

[5] Collares Pereira, M. (Ed.): "The Potential for Solar Assisted Cooling in Southern European Countries", DER-ITE/INETI, Lisboa, 1995