Folder Title:	Kenya - ESMAP - Energy Efficiency in Tea Industry - Correspondence - Volume 2
Folder ID:	30435022
Series:	Operational support and ESMAP project management
Dates:	10/01/1986 - 06/22/1987
Fonds:	Records of the Energy Sector
ISAD Reference Code:	WB IBRD/IDA ENGY-03
Digitized:	05/15/2023

ESMAP: KENYA
ENERGY EFFICIENCY IN TEA INDUSTRY II

THE WORLD BANK / INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

DATE: May 20, 1986

TO: Files

FROM: Reza Khonsary (Consultant), EGYS2 RK

EXTENSION: 7-2098

SUBJECT: ESMAP: KENYA - Coal and Tea Studies

1. On May 15, 1986, I called the office of the Australian Executive Director for an appointment with Mr. William Bowen, Assistant to the Australian Director, in order to brief him on the status of the Coal and Tea studies financed largely by the Australian Government (ADAB). On May 16, Mr. Bowen returned my call but he did not think that we needed to see him since it was his last day in the office before taking a leave.

2. I briefed Mr. Bowen over the telephone on the status of the Coal and Tea studies. I informed him that we have had the draft final reports at the end of March which we reviewed and commented on. I mentioned that we were not happy with the reports since they were weak in economic analysis and policy aspect. Furthermore, I briefed Mr. Bowen on the timing for the revision of the reports and audits as presently scheduled (end of May) and mentioned that if we are satisfied with the revisions, we would go to Nairobi the last week of June for final review of the reports and audits.

3. Mr. Bowen was concerned to hear about the quality of the reports. However, he did not think that it was necessary for him at this stage to brief his authorities since the consultants were revising the reports. He thought he would wait until the reports are revised and then we should let him know what we thought of the reports. At that time, he would decide what he should do.

4. Mr. Bowen appreciated my briefing him and mentioned that Mr. Wilson from ADAB will visit Washington on June 18 and we could talk to him about the possibility of ADAB's financing other ESMAP projects.

Cl. w&cc: Mr. Poncia (EGYS2)

cc: Messrs. de Capitani, Bates (EGYS2)

RKhonsary:cah

THE WORLD BANK / INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

DATE: May 29, 1986

TO: Files

FROM: Reza Khonsary (Consultant), EGYS2 RK

EXTENSION: 7-2098

SUBJECT: ESMAP: KENYA - Coal and Tea Studies

1. Today at 7:00 a.m., I received a call at home from Mr. Malcolm Nicklin, the team leader, Macdonald Wagner, to request a postponement of the Nairobi meeting from end of June to first week of October. Mr. Nicklin explained that they cannot complete the Reports on time for Bank and Government review and they would like to have extra time to spend on the revision of the Reports. Mr. Nicklin indicated that he has already discussed this with Mr. S. A. R. Bagha (MOERD), who is now in Sydney helping with the revision of the Reports, and Mr. Bagha has agreed with the postponement. Mr. Nicklin said the revised Reports will be ready by mid-July for Bank and Government review. He wanted to find out Bank's reaction to this postponement.

2. I told Mr. Nicklin that we are not interested in incomplete Reports and he should see to it that our comments are all taken into consideration and the Reports are revised accordingly before he submits them to the Bank and Government. I asked Mr. Nicklin to send us a telex requesting the postponement. I indicated to Mr. Nicklin that I would discuss his request with my superiors upon receipt of his telex and try to get their agreement to his request for postponement.

cc: Messrs. de Capitani, Bates, Poncia, Broadfield (EGYS2)
Schramm, Newcombe (EAPEG)

RKhonsary:cah

MAY 15 1986 D451

THE WORLD BANK / INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

① de Capitani
② Bates
③ files - ESMAP

DATE: May 13, 1986

TO: Mr. C. Poncia, Senior Operations Officer, EGYS2

FROM: J. Van der Ven, Sr. Economist, EAPTR

EXTENSION: 75879

SUBJECT: KENYA - Coal Conversion Action Plan
Draft Consultants Report, March 1986

1. We have reviewed Chap 9 dealing with handling facility and transport requirements. The following are our comments.

2. It is noted that the mid-project review: (i) determined that there is little or no potential for the conversion from existing fuels to coal as a source of energy; and (ii) decided that the consultants would still report on the infrastructure which would be required should, for any reason, coal quantities imported into Kenya be increased beyond the current use by Bamburi Portland Cement Co.

3. In respect of port capacity the minimum requirement is to satisfy the growth of coal imports for cement production. On this point, the consultants conclude (para. 9.7.5) that this growth can be accomodated at the existing 2 MBARAKI berths under the various scenarios of imports and exports of other bulk goods. Under the most pessimistic scenario there would still be capacity for 50,000 t.p.a. of imports of steaming coal for industrial use. If bagged cement exports are static or decline, imports of steaming coal could be increased to the 300,000 - 580,000 t.p.a. range. While these handling volumes are technically feasible, they will require a high level of management control, in particular of the storage areas where in addition to coal, bagged cement, clinker, fluorspar, molases and gypsum would have to be stored and evacuated in relatively small quantities. A condition for achieving the higher levels of throughput of steaming coal is clearly that greater emphasis will have to be given to good operational control of the whole operation. The consultants may wish to underline this in their report.

4. With respect to evacuation of coal from the port the consultants conclude that (i) transport of coal cement production at Bamburi would be by road and that capacity is adequate (para 9.6.1) and (ii) transport of coal for other uses would be by rail for which a maximum capacity of 600,000 t.p.a. is postulated (para. 9.6.2.2). The latter transport volume assumes 3 trains per day from Mombasa to Nairobi devoted to coal out of a maximum of 13 freight trains per day and that there is hardly any growth in Kenya Railways' traditional traffic. The transport of 600,000 t.p.a. of coal is technically feasible but in practice would require much improvement in Kenya Railways' operational performance. However, if such improved performance were to materialise, then Kenya Railways would be transporting higher volumes of its traditional traffic and in the absence of investments to increase line capacity, the available capacity for coal transport would be correspondingly reduced. While such investments would be perfectly

justified they would have to be planned sufficiently well in advance. In sum, transport by rail of the higher volumes is conditional upon significant improvements in operational performance and selective investments to increase line capacity. It would be indicated to bring this out in the report.

cc: Messrs. Brown, Capoluongo, Litvak, de Capitani, Khousary

5/12/86
ESMAP. Kenya. Coal + Tea
① Khonsary
② Poncia
③ de Castro
④ files

ZCZC DIS12170 RCA2429
EGY82 EA1KU
REF : TCP1 MET

RCA2429
248423 WORLDBANK
MACDAS AA24204

MACDAS AA120836
WBK101/120586/1210

MESSAGE TO: WORLD BANK - WASHINGTON

FOR: MESSRS PONCIA/KHONSARY
ENERGY DEPARTMENT EGY82
WORLD BANK

COPY TO: MESSRS NYOIKE/BAGHA
MINISTRY OF ENERGY
NAIROBI - KENYA

MR. M.H. THOMAS
MERZ AND MCLELLAN

SUBJECT: KENYA COAL AND TEA STUDIES (WB TELEX 07 MAY 86)

AA) REFERENCE ITEM (DDD) W.B. TELEX
+ WE CAN PRINT IN PRESTIGE ELITE - 12 SPACE AT BOTH MACDONALD WAGNER AND MERZ OFFICES.
+ ALL 40 AUDIT REPORTS WERE PREPARED IN MERZ OFFICE WHERE THE WORD PROCESSOR COMPUTER IS AN NCR TOWER 1632 AND THE SOFTWAR E IS ''WORDMARK''.
+ THE TWO VOLUMES OF MAIN REPORTS AND TWO VOLUMES OF APPENDICE S (EXCEPT APPENDIX C TEA REPORT WHICH IS ON MERZ WORD PROCESSOR)ARE NOW IN MACDONALD WAGNER WORD PROCESSOR THE COMPUTER FOR WHICH IS A DEC LSI 11/73 AND THE SOFTWARE FOR WHICH IS LEX ELEVEN (LEX 11).

BB) ALTHOUGH THE TOTAL PAYMENT TO US FOR OUR TWO INVOICES DATED 30 APRIL OF 21,852.15 IS CORRECT THE TEA PROJECT INVOICE IS OVERSTATED WITH A CORRESPONDING UNDERSTATEMENT OF THE COAL PROJECT INVOICE.
PLEASE MAKE CORRECTIONS AS SET OUT ITEMS (CC) AND (DD) BELOW FIRST MAKING CORRECTION TO ONE CENT TYPING ERROR ON INVOICE 6A WHERE DECIMAL 33 SHOULD BE DECIMAL 32 TWICE AND DECIMAL 73 SHOULD BE DECIMAL 72 TWICE.

CC) REFERENCE TEA PROJECT INVOICE NO.6A PLEASE AMEND ADJUSTMENT TO C-12 TO READ LESS 6,056.81 NOT PLUS 1,756.32 WITH CORRESPONDING CHANGES 13,036.32 TO READ 5223.19 AND PAYMENT OF 14,356.72 TO READ 6,453.59 TWICE. TO DO THIS I HAVE TRANSFERRED ALL OF THE

TIME IN AUSTRALIA OF 7,813.13 (ITEM 22) TO ITEM 2 OF THE COAL
INVOICE NO.10 LEAVING ITEM 22 TO BE NIL FOR THE PERIOD.

DD) REFERENCE COAL PROJECT INVOICE NO.10 PLEASE AMEND ADJUSTMENT TO

C-6 TO READ PLUS 19,624.60 NOT PLUS 11,811.47 WITH CORRESPONDIN
G
CHANGES 13,771.47 TO READ 21,584.60 AND PAYMENT OF 7,495.43 TO

READ 15,308.56 TWICE. PLEASE INCORPORATE ITEM 22 FROM TEA
BILLING INTO ITEM 2 OF COAL BILLING.

EE) ITEMS (CC) AND (DD) WILL BRING TOTAL PAYMENTS TO US (UPON
RECEIPT OF PAYMENT OF INVOICES 10 AND 6A) TO:

+ COAL DOLLARS AUST. 621,241.46
+ TEA DOLLARS AUST. 201,723.58
+ FOR COAL THIS IS 501,265.99 (APPENDIX C5) PLUS 118,015.47 (APPENDIX D1) TOTALLING 619,281.46 TO END MARCH 1986 PLUS 1,960.00 ADVANCE PAYMENT - PLEASE AMEND PAGE 3 OUR PROGRESS REPORT DATED 5 MAY 86.
+ FOR TEA THIS IS 147,093.57 (APPENDIX C11) PLUS 40,761.01 (APPENDIX D3) TOTALLING 187,879.58 TO END MARCH 1986 PLUS 13,844.00 ADVANCE PAYMENT - PLEASE AMEND PAGE 3 OUT PROGRESS REPORT DATED 5 MAY 86.

FF) PLEASE ACCEPT THIS TELEX AS YOUR FORMAL INSTRUCTION TO AMEND OU
R
INVOICES 10 AND 6A BY TRANSFERRING CHARGES UNDER ITEM 22 TEA
INTO ITEM 2 COAL AND REDUCING ITEM 22 TO NIL. PLEASE ACCEPT MY

APOLOGY FOR ANY INCONVENIENCE INCURRED. WE LOOK FORWARD TO
EARLY PAYMENT OF BOTH INVOICES AS AMENDED.

GG) THANK YOU FOR YOUR ACCEPTANCE OF OUR REQUEST TO ASSIST IN
PRINTING AND DISTRIBUTING THE FINAL REPORTS.

HH) WITH PERSONAL REGARDS TO ALL,

MALCOLM NICKLIN.

MACDAS AA120836

248423 WORLDBANK
MACDAS AA24204

=05120227

=05120627

ALT RTD FROM:YS2M

NNNN

2/18/86

5/30/86
Kenya. ESMAP - Coal & Tea
① Khonsary
② ~~Poncia~~
③ de Capitani ④ files

ZCZC DIST4883 RCA6568
EGYS2 EA1KU
REF : TCP D.S.

RCA6568
248423 WORLDBANK
MACDAS AA24204

MACDAS AA120836
WBK101/300586/1446

MESSAGE TO: WORLD BANK - WASHINGTON

FOR: MESSRS DE CAPITANI/PONCIA/KHONSARY
ENERGY DEPARTMENT EGYS2 ROOM D444
WORLD BANK

FROM: MALCOLM NICKLIN
MACDONALD WAGNER
SYDNEY

SUBJECT: KENYA COAL AND TEA STUDIES

AA) REFFERENCE MY TELEPHONE CONVERSATION YESTERDAY WITH MR. REZA KHONSARY.

BB) I CONFIRM MY RECOMMENDATION FOR WHICH I SEEK YOUR APPROVAL TO POSTPONE THE MEETINGS SCHEDULED FOR LAST WEEK IN JUNE IN NAIROB
I
TO BE ATTENDED BY MOERD, WORLDBANK AND OURSELVES UNTIL OCTOBER PREFERABLY MID OCTOBER.

CC) WE DO REQUIRE MORE TIME TO COMPLETE THE SENSITIVITY ANALYSES, DRAW CONCLUSIONS FROM THEM AND THEN TO REVIEW ALL ASPECTS OF AL
L
REPORTS AS A TEAM PRIOR TO RE-ISSUING OUR FINAL DRAFTS. TO FIT COMMITMENTS OF KEY PERSONNEL PARTICULARLY MYSELF WE WILL NOT BE ABLE TO REISSUE THE REPORTS UNTIL MID JULY (APPROX. 12 JULY).

DD) MR. BAGHA OF MOERD WILL NOT BE IN KENYA DURING AUGUST AND NICKLIN WILL BE AWAY FROM AUSTRALIA IN SEPTEMBER. HE WILL BE I
N
ENGLAND EARLY IN OCTOBER AND WOULD APPRECIATE IT IF THE NAIROBI MEETINGS COULD BE TIMED TO COINCIDE WITH HIS RETURN FROM THERE THAT IS HE TRAVELS VIA NAIROBI.

EE) THE VISIT OF MR. BAGHA HAS BEEN VERY FRUITFUL AND HE WILL BE PROVIDING US WITH ADDITIONAL INFORMATION UPON HIS RETURN TO NAIROBI. I WILL STILL GO TO NAIROBI FOR 2 DAYS EN ROUTE HOME FROM ARGENTINA AT END JUNE TO HAVE FURTHER DISCUSSIONS WITH BAGHA AND KTDA BEFORE WE REISSUE OUR REPORTS MID JULY.

FF) WITH PERSONAL REGARDS. PLEASE BE ASSURED THAT THIS ADDITIONAL

TIME FOR US NOW WILL GREATLY ENHANCE THE EFFICACY OF OUR REPORT
S
AND CONCLUSIONS.

MALCOLM NICKLIN.

MACDAS AA120836

248423 WORLDBANK
MACDAS AA24204

=05300513

=05301000

ALT RTO FROM:YS2M

NNNN

(3/82)

WORLD BANK OUTGOING MESSAGE FORM Cable, Telex

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Typewritten Character Must Fall Completely in Box!

PAGE 1 OF 1

OFFICIAL DEPT/DIV ABBREVIATION: EGYS2

MESSAGE NUMBER:

TEST NUMBER (FOR CASHIER'S USE ONLY):

START HERE

MR. MALCOLM NICKLIN, TEAM LEADER, MACDONALD WAGNER, SYDNEY AUSTRALIA. COPY TO MR. P.M. NYOIKE, MOERD, MR. JAMES ADAMS, DIRECTOR, RMESA, INTBAFRAD, NAIROBI, KENYA. RE COAL AND TEA STUDIES AND YOUR TELEX OF MAY 30. (AAA) HAVING REVIEWED YOUR FASCIMILE OF MAY 23 RESPONDING TO OUR DETAILED COMMENTS OF APRIL 17 ON YOUR DRAFT, WE ACCEPT YOUR REQUEST FOR MORE TIME NOT ONLY TO COMPLETE THE SENSITIVITY ANALYSIS BUT ALSO TO TAKE INTO ACCOUNT FULLY OUR COMMENTS AND APPROPRIATELY REVISE THE REPORTS. WE LOOK FORWARD TO RECEIVING YOUR FULLY REVISED DRAFT REPORTS BY MID-JULY AS YOU HAVE NOW PROPOSED. (BBB) IN VIEW OF THE NEED FOR EXTENSIVE REPORT REVISION, WE AGREE THAT THE PROPOSED REVIEW MEETING IN NAIROBI ON JUNE 24 SHOULD BE POSTPONED. AFTER WE RECEIVE AND REVIEW YOUR REVISED DRAFTS, WE WILL MAKE SPECIFIC PROPOSALS FOR THE FURTHER PROCESSING OF THE STUDY REPORTS AND AUDITS, INCLUDING A TIMETABLE FOR REVIEW WITH GOVERNMENT AND THE BANK. (CCC) WE ARE PLEASED THAT MR. BAGHA'S VISIT TO SYDNEY HAS BEEN FRUITFUL AND THAT HE WILL CONTINUE TO PROVIDE YOU WITH ADDITIONAL INFORMATION FOR REVISION OF THE REPORTS UPON HIS RETURN TO NAIROBI. REGARDS, R. BATES, ACTING DIVISION CHIEF, EGYS2, ENERGY DEPARTMENT. INTBAFRAD.

END OF TEXT

PINK AREA TO BE LEFT BLANK AT ALL TIMES

INFORMATION BELOW NOT TO BE TRANSMITTED

CLASS OF SERVICE: Telex	TELEX NO.: BOOK OF THREE	DATE: 6/5/86	
SUBJECT: ESMRR: KENYA - Coal & Tea Studies	DRAFTED BY: /RKhonsary:cah	EXTENSION: 7-2098	
CLEARANCES AND COPY DISTRIBUTION: Cl.w&cc: Messrs. Schramm(EAPEG), McBride (EA1) cc: Messrs. Wackman, Newcombe (EAPEG), Poncia (EGYB2 cc Broadfield (EGYS2)	AUTHORIZED BY (Name and Signature): R. Bates, Acting Div. Chief, EGYS2 DEPARTMENT: Energy SECTION BELOW FOR USE OF CABLE SECTION CHECKED FOR DISPATCH		

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FORM NO. 27 OCR (3/82)

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BOOK OF THREE

1. MR. MALCOLM NICKLIN
MACDONALD WAGNER
SYDNEY, AUSTRALIA
TELEX NO. AA20836

2. MR. P. M. NYOIKE
MINISTRY OF ENERGY AND REGIONAL DEVELOPMENT
NAIROBI, KENYA
TELEX NO. 23094 MINERGY

3. MR. JAMES ADAMS
DIRECTOR
INTBAFRAD
NAIROBI, KENYA
TELEX NO. 22022

END OF TEXT

PINK AREA TO BE LEFT BLANK AT ALL TIMES

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SUBJECT:	DRAFTED BY:	EXTENSION:
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WORLDBANK MSS

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12/11

Khonsary Files

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EGYS2 EA1KU
REF : TCP D.S.

RCA9133
248423 WORLDBANK
MACDAS AA21204
MACDAS AA120836
WBK101/111286/1607

FOR : MESSRS ROBIN BATES/ROBIN BROADFIELD/REZA KHONSARY
EGYS2
WORLD BANK

FROM: MALCOLM NICKLIN
MACDONALD WAGNER
SYDNEY AUSTRALIA

SUBJECT: KENYA COAL AND TEA PROJECTS

AA) VOLUME TWO OF EACH REPORT HAS BEEN EDITED AND PRINTED READY FOR BINDING ONLY HOLDUP IS ONE TABLE IN APPENDIX F WHERE I AM STILL WAITING FOR JUST A FEW NUMBERS FROM NAIROBI PROMISED TO ME WITHIN TEN DAYS OF OUR DEPARTURE FROM NAIROBI. IT WOULD APPEAR THAT WHEN MR BAGHA IS AWAY FROM NAIROBI LITTLE HAPPENS. HIS SIX WEEKS IN JAPAN HAS BLOWN OUT TO EIGHT.

BB) VOLUME ONE OF EACH REPORT NEARS COMPLETION BUT DELAYED SOMEWHAT AS MARTIN THOMAS, JOHN SPENCE, TONY O'MALLEY AND I HAVE HAD LITTLE OPPORTUNITY TO MEET TOGETHER SINCE MY RETURN FROM NAIROBI.

CC) RE COAL VOL 1: CHAPTERS 3 AND 6 HAVE BEEN MERGED AND THE NEW CHAPTER 3 IS PRESENTLY BEING PUT INTO OUR WORLD PROCESSOR. HOPEFULLY THE WHOLE NEW CHAPTER (PRIOR TO FINAL EDIT) WILL BE SENT TO YOU BY FACSIMILE TOMORROW FIRDAY SYDNEY TIME. CHAPTERS 2, 4, 6 (OLD 7) AND 7 (OLD 8) ARE QUITE COMPLETE READY FOR FINAL PRINTING. CHAPTER 5 IS BEING EDITED NOW THAT SENSITIVITY TESTING HAS BEEN REDONE FOLLOWING MARTIN THOMAS' TEAM RE-DOING EVALUATION OF PROJECTS. CHAPTER ONE EXEC. SUMMARY WILL BE REWORKED WHEN CHAPTERS 3 AND 5 ARE COMPLETE IN ALL RESPECTS.

DD) RE TEA VOL 1. ALL CHAPTERS COMPLETE EXCEPT 5 AND 8 FOR SAME REASONS AS FOR COAL IN ITEM CC ABOVE. EXEC. SUMMARY SIMILARLY.

EE) ALL FINAL REPORTS (NUMBER OF COPIES PER YOUR DISCUSSIONS WITH MARTIN THOMAS IN WASHINGTON AFTER NAIROBI MEETINGS) WILL DEFINITELY BE DESPATCHED TO NAIROBI AND WASHINGTON BY CHRISTMAS EVE

AS FORECAST IN NAIROBI.

FF) I WOULD BE MOST GRATEFUL IF ROBIN BROADFIELD WOULD TELEPHONE ME AT MY HOME (SYDNEY 969 6558) AT 3.00PM (1500 HOURS) THURSDAY 11 DECEMBER WASHINGTON TIME THAT IS 7.00AM (0700 HOURS) SYDNEY TIME FRIDAY MORNING 12 DECEMBER TO DISCUSS PROGRESS AND REPOR
T
PRINTING AND DESPATCH.

GG) KIND REGARDS TO YOU ALL - COMPLIMENTS OF THE SEASON.

FROM
MALCOLM NICKLIN.

MACDAS AA120836.
248423 WORLDBANK

=12110537

=12110714

NNNN

THE WORLD BANK/INTERNATIONAL FINANCE CORPORATION
Washington D. C. 20433
U.S.A.

FORM NO. 1884
(1-86)

FACSIMILE TRANSMITTAL FORM

CABLE SERVICES USE ONLY	
MSG. NUMBER:	
DURATION OF CALL:	MINUTES

DATE:

NUMBER OF PAGES: 3 (Including this page)

FROM: Robin A. Broadfield   Extension 74031   Dept/Div., No. 352/50

TO: COMPANY/ORGANIZATION: Malcolm Nicklin, Macdonald Wagner
CITY AND COUNTRY: 100 Miller St.
FOR ATTENTION OF: North Sydney
New South Wales 2060
Australia

FAX NUMBER/
MACHINE TYPE: 61 2 9576764

SUBJECT: Kenya Coal and Tea Projects

cc:

Transmission Authorized by: Bernard Montfort, Division Chief, EGYS1

Original to be returned to: Holly Mensing ext. 74219   Room No.: D-639

If you experience any problems with this transmission, please call back as soon as possible.
Phone: (202) 477-2805/2021

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TELEX: RCA - 248423 WORLDBK; ITT - 440098 WORLDBANK;
FTCC - 82987 WORLDBK; TRT - 197688 WORLDBANK WUI - 64145 WORLDBANK

Kenya Coal and Tea Projects

1. Chapter 3 is a considerable improvement on earlier drafts. It still lacks (a) focus on major issues with respect to energy policy; and (b) a clear, logical structure.

2. Suggestions for overcoming these weaknesses are as follows:

(a) Switch presentation and justification of financial and economic prices used in project evaluation to early in the project analysis chapter. This means extracting Table 3.4 and associated text from Chapter 3 and setting them into a new section of the project analysis chapter headed "Fuel price assumptions for project analysis and sensitivity testing." This section should explain how these prices relate to current market and economic prices presented in Chapter 3.

(b) Organize Chapter 3 into three main sections:

I. Pattern of industrial energy consumption.

II. Energy supply policy and scope for expanding indigenous production. (e.g., fuelwood--but don't discuss only the thinnings proposal).

III. Energy demand policy and recommendations for improvement therein, covering:

(i) Energy conservation awareness efforts--describe current policies briefly, as introduction to recommendations in Chapter 7.

(ii) Pricing--compare current market prices with economic cost of supply and recommend actions to bring former in line with latter.

(iii) Price control policy--setting out your proposal and linking back to awareness issue.

(iv) Tariff policy--quantifying costs of tariff relief and justifiying this favorable treatment for energy equipment imports.

(v) Cost of capital and tax policy.

Material that does not fit with this framework and does not have direct implications for analysis of Kenyan energy management efforts should be dropped.

3. Minor points that might help final drafting are:

(a) Drop references to "the consultants"--write in third person;
(b) Use "residual" not "refinery" fuel oil;
(c) Discuss objective of energy pricing principally in terms of promoting efficient choice and use of fuels and providing appropriate incentives to potential suppliers; minimize or drop talk of social objectives/equity (3.3.1);
(d) Why only "private" transport (3.3.2.1.);
(e) Quantify distortions in petroleum pricing (3.3.2.1) and beware of blanket endorsement as in last paragraph;
(f) Quantify difference between fuelwood costs and price (3.3.2.2);
(g) Objective of electricity pricing is presumably to moderate price increases, not reduce prices (3.3.2.3);
(h) Be more specific about potential supply policies or drop generalizations (3.4);
(i) Drop premature references to results of audit program in what should be an evaluation of policy (3.4.2);
(j) Give a date for Table 3.3;
(k) Prune the material in 3.5; drop references to audit results; bring text and title into alignment;
(l) Remove repetition between third and fourth paragraphs (pages 3-24); and
(m) Drop references to Bank in Policy Impacts section.

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MACDAS AA120836
WBK101/241286/1132

rccd 12/24/86

~~① Bates~~
~~② Broadfield~~
③ ~~Khowsary~~
④ files

TELEX TO : WORLD BANK WASHINGTON

FOR : MESSRS ROBIN BATES/ROBIN BROADFIELD/REZA KHOWSARY
EGYS2 (ROOM D439)

FROM : MALCOLM NICKLIN
MACDONALD WAGNER
SYDNEY AUSTRALIA

SUBJECT : KENYA COAL AND TEA PROJECTS

AA) SINCERE CHRISTMAS AND NEW YEAR GREETINGS TO YOU ALL.

BB) TKS YR PROMPT FASCIMILE FOLOWING OUR TELECON LAST WEDNESDAY. SPENCE/O'MALLEY/THOMAS/SELF ABSORBING IT OVER FESTIVE SEASON.

CC) VOLUME 2 FOR EACH PROJECT IS NOW PRINTED AND BOUND.

DD) ABOUT HALF OF EACH OF THE VOLUMES ONE BEING PRINTED WHEN OFFICE REOPENS 5 JAN BUT AS SYDNEY IN JANUARY IS LIKE PARI
S
IN AUGUST (EVERYONE ON HOLIDAY) DOUBTFUL WHETHER BALANCE OF VOLUME ONE FOR EACH REPORT CAN BE FINALISED IN ALL RESPECTS, PRINTED, BOUND AND DESPATCHED BEFORE FEBRUARY BUT I CONFIRM ROBIN BROADFIELD'S ADVICE THIS PROGRAMME O.K

NATURALLY I WILL DO MY DARNEST TO FINISH REPORTS EARLIER S
O
I CAN REALLY START MY 'RETIREMENT' AND NOT CONTINUE TO ATTEND THE OFFICE EACH DAY AS A 'FREEWILL OFFERING'.

BEST REGARDS
MALCOLM NICKLIN
MACDONALD WAGNER

MACDAS AA120836

248423 WORLDBANK
MACDAS AA24204

=12240056

=12240054

NNNN

MERZ & McLELLAN & PARTNERS

Engineers and Project Managers

5 HARBOUR VIEW CRESCENT, MILSONS POINT,
N.S.W. 2061, AUSTRALIA
POSTAL ADDRESS: PRIVATE BAG 820, MILSONS POINT, N.S.W. 2061

TELEPHONE: (02) 922 2666
TELEGRAMS: AMBERSD SYDNEY
TELEX: AA121126
FACSIMILE: (02) 957 1474

ALSO
BRECON, 47 COLIN STREET, WEST PERTH, W.A. 6005 TEL (09) 322 2433 TELEX AA92311 FACS (09) 325 5972
11 QUEENS ROAD, MELBOURNE, VIC. 3004 TEL (03) 266 2524 TELEX AA30930 FACS (03) 267 1046
127 CREEK STREET, BRISBANE, QUEENSLAND, 4000 TEL (07) 229 6911 TELEX AA121126 FACS (07) 229 6249
47 KNUCKEY STREET, DARWIN, N.T. 5790 TEL (089) 81 4433 TELEX AA85471 FACS (089) 81 5946
3 BROOKE STREET, HOBART, TASMANIA, 7000 TEL (002) 34 9717 TELEX AA121126 FACS (002) 23 4291

Your Ref:
Our Ref: 624:01
MHT:JK

16 January 1987

PREINVESTMENT DIV. I
Dt. Recd. 1/28 Log No. 4188
For Action To: ~~Broadfield~~
For Info. To: ~~Montfort~~
B
Action Taken On: 2/2/87
Reference File: Keny Coal

Attention: Mr A R Broadfield

Energy Strategy and Preinvestment Division 2
The World Bank
1818 H Street NW,
WASHINGTON DC 20433 USA

Dear Robin

KENYA - COAL & TEA ENERGY PROJECTS

As discussed at our meeting in Washington on the 24th October, I now have pleasure in enclosing single unpunched sheets of each of those pages of the Kenya Energy Audit Reports which have been modified. In general the altered sheets include only the first page of each Executive Summary where, as requested, we have included a caveat covering the changing fuel prices and their possible effect on some of the T2 investment projects identified.

You already have unpunched pages for all 40 of the Energy Audit Reports (21 Coal and 19 Tea) and all that should now be done is that original pages should now be replaced with those enclosed, following which the reports can be printed, bound and issued.

The revised Executive Summary pages are of course all included in the appropriate Appendix of Volume 2 of each of the Coal and Tea final reports, and these are being transmitted to you under separate cover by Malcolm Nicklin.

.../2

I am sending two punched copies of the replacement pages to Mr S A R Bagha of the Ministry of Energy and Regional Development in Nairobi, one for his office copy and one for the copy sent to industry. Finally I should mention I am having a very limited further printing run undertaken for distribution of copies to key memebers of the consultancy team.

With this issue of the updated replacement pages I can say, I hope, that we have now completed all responsibilites on production of the 40 Kenya Energy Audit Reports. Although quite a substantial effort, our objective and hope is of course that each one will be reviewed seriously by the management concerned, and that effective action will be taken to improve energy management. I hope also that through the MOERD the reports will provide a model and example for ongoing industrial energy audit work in Kenya.

As to the future, as you know we sincerely hope to be further involved with development of the Kenyan energy management programme and, in particular, development of full feasibility studies and perhpas engineering of the more attractive of the T2 projects.

In the meantime may I say that it has been a great pleasure working with you and I would like to thank you most warmly for the considerable and constructive support you gave us in Nairobi, and again in Washington and in subsequent correspondence, all of which has helped to make the whole effort much more effective. Your personal contribution to this has been singularly appreciated by all of us.

With very best wishes for the coming year,

Yours sincerely

Martin Thomas

MARTIN THOMAS

Enc. Modified Executive Summary sheets (1 copy) for replacement in Kenya Energy Audit Reports (unpunched).

cc Mr S A R Bagha - Ministry of Energy & Regional Development
Mr M S Nicklin - Macdonald Wagner Pty Ltd
Mr J A Spence/Mr A O Malley - Coopers & Lybrand W D Scott

624:01
MHT:JK 16 January 1987

Attention: Mr S A R Bagha

Ministry of Energy and Regional
Development
Room 2110, Floor 21
Nyayo House
Nairobi
KENYA

Dear Mr Bagha

COAL & TEA ENERGY AUDIT REPORTS

Firstly may I wish you, your wife and family, and all your colleagues the very happiest New Year and all good wishes for every success in 1987. I have the feeling that it must be a good year for us all!

I am enclosing a letter I have written to Robin Broadfield which is self explanatory. With it I enclose two copies of each of the Executive Summary pages of the 40 Energy Audit Reports which were slightly modified following our meetings with the World Bank. The modifications are very minor, amounting only to the addition of a warning to users to analyse the effect

.../2

of changing fuel prices since the time of the audit should they wish to proceed with any of the T2 projects identified.

As you will know from my earlier letter, I am hopeful that the opportunity will arise to take forward to full feasibility study level at least some of the more attractive T2 projects. You will probably have more time to think of this once you have received the final bound copies of Volumes 1 and 2 of the Coal and Tea reports. These are being sent to you separately by Malcolm Nicklin, and now include the required economic and sensitivity analyses of the T2 projects which you will, I hope, find most interesting.

In the meantime I sincerely hope that your visit to Japan was a tremendous success, and that your dedicated work in the field of energy management in Kenya proceeds with enthusiasm and effectiveness. Under your direction I am sure it will.

Again with my kindest regards, which I would be very glad if you would pass on to Vida.

Yours sincerely

MARTIN THOMAS

Encl. Modified Executive Summary sheets (2 copies), suitably punched for inserting in existing spiral bound reports. One set for MOERD, one set for Clients.

cc: Mr Robin Broadfield - World Bank, Washington
Mr Malcolm Nicklin - Macdonald Wagner

ZCZC DIST8472 RCA8052
EGYS1 EGYS2 EA1KU
REF : TCP1 MET
****
* EGYS1 *
****

1/30 4214
~~Broadfield~~
~~Montfort~~
copy sent to Mr Khonsary
2/2/87
Kenya Coal

RCA8052
248423 WORLDBANK
MACDAS AA24204

MACDAS AA120836
WBK101/300187/1654

TELEX TO : WORLD BANK WASHINGTON
ATTENTION : MESSRS ROBIN BATES/ROBIN BROADFIELD/REZA KHONSARY
EGY S2 (ROOM D438)

RE : KENYA COAL AND TEA PROJECTS

FURTHER TO MY TELEX 24 DECEMBER 1986 HEREUNDER BRIEFLY PROGRESS ON FINAL REPORTS.

AA) CHAPTERS 3 AND 5 (COAL) HAVE BEEN RE-ARRANGED ALONG THE LINES SUGGESTED YOUR FACSIMILE 17 DECEMBER. SUBSEQUENTLY EQUIVALENT CHAPTERS 5 AND 8 (TEA) WERE RE-ARRANGED SIMILARY.

BB) TONY O'MALLEY AND I WITH THE HELP OF MY WORD PROCESSOR OPERATOR WHEN SHE RETURNED FROM HOLIDAY HAVE TODAY COMPLETED WHAT WE FEE L IS THE FINAL FINAL DRAFT OF ALL FOUR CHAPTERS ABOVE AND THIS AFTERNOON COPIES WERE PLACED ON THE DESKS OF MARTIN THOMAS AND JOHN SPENCE BOTH OF WHOM RETURN TO THEIR OFFICES FROM NEARLY THREE WEEKS LEAVE ON MONDAY NEXT. I AM ASKING BOTH FOR THEIR FINAL COMMENTS BY THURSDAY NEXT.

CC) THE FIRST REDRAFT OF THE NEW FINAL DRAFT EXECUTIVE SUMMARIES WILL NO BE COMPLETED BY ME THIS WEEKEND VIEW TO REACHING TEAM AGREEMENT FOR FINAL ENTRY INTO WORD PROCESSOR BY FRIDAY 6TH FEB
.

DD) SUBJECT TO ABOVE PROGRAMME BEING MET I SHOULD BE ABLE TO DESPATCH TO WASHINGTON AND NAIROBI FINAL REPORTS (BOUND AND UNBOUND) ON FRIDAY 13 FEBRUARY BROADLY AS AGREED WITH ROBIN BROADFIELD. I WILL THEM RENDER OU FINAL ACCOUNTS IN MARCH.

EE) PLEASE CONFIRM RECEIPT OF REPLACEMENT SHEETS FOR THE 40 AUDIT REPORTS WHICH NOW ENABLES YOU TO PRINT YOUR REQUIRED ADDITIONAL NUMBER OF COPIES.

FF) ALTHOUGH VOLUME TWO OF EACH REPORT IS PRINTED AND BOUND READY FOR DESPATCH I WILL AWAIT SENDING THE COPIES TO YOU AND MOERD UNTIL I SEND THE VOLUMES ONE UNLESS OF COURSE YOU SIGNIFY OTHERWISE.

BEST WISHES
~~MALCOLM NICKLIN~~
MACDONALD WAGNER

MACDAS AA120836

248423 WORLDBANK
MACDAS AA24204

=01300638

=01300901

NNNN

ZCZC DIST8472 RCA8052
EGYS1 EGYS2 EA1KU
REF : TCP1 MET
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RCA8052
248423 WORLDBANK
MACDAS AA24204

MACDAS AA120836
WBK101/300187/1654

1/30 4214
Broadfield
~~Moolgoot~~
copy sent to Mr Khonsary
2/2/87
Kenya Coal

TELEX TO : WORLD BANK WASHINGTON
ATTENTION : MESSRS ROBIN BATES/ROBIN BROADFIELD/REZA KHONSARY
EGY S2 (ROOM D438)

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BEST WISHES
~~MALCOLM NICKLIN~~
MACDONALD WAGNER

MACDAS AA120836

248423 WORLDBANK
MACDAS AA24204

=01300638

=01300901

NNNN

WORLD BANK OUTGOING MESSAGE FORM Cable, Telex

IMPORTANT—PLEASE READ INSTRUCTIONS BELOW BEFORE TYPING FORM

Typewritten Character Must Fall Completely in Box!

PAGE 1 OF 1

OFFICIAL DEPT/DIV ABBREVIATION: EGYS1

MESSAGE NUMBER:

TEST NUMBER (FOR CASHIER'S USE ONLY):

START HERE

TO MR. MALCOLM NICKLIN, MACDONALD WAGNER, SYDNEY, AUSTRALIA. RE: KENYA COAL AND TEA STUDIES AND CHERIE PERT'S TELEX OF FEBRUARY 13, 1987. (AAA) THIS IS TO INFORM YOU THAT WE HAVE RECEIVED THE REPLACEMENT SHEETS FOR THE 40 AUDIT REPORTS. (BBB) WE HAVE NO OBJECTION TO YOUR AIRFREIGHT SHIPMENT OF THE FINAL COAL AND TEA REPORTS. THE SHIPMENT SHOULD BE SENT TO WASHINGTON DULLES INTERNATIONAL AIRPORT, TO BE DELIVERED TO PANALPINA AIRFREIGHT, INC. (BANK'S FORWARDING AGENT) FOR CUSTOMS CLEARANCE AND DELIVERY TO OUR OFFICE. THANK YOU. BEST REGARDS, ROBIN BATES, ACTING DIVISION CHIEF, ENERGY STRATEGY AND PREINVESTMENT DIVISION I, WORLD BANK.

END OF TEXT

PINK AREA TO BE LEFT BLANK AT ALL TIMES

INFORMATION BELOW NOT TO BE TRANSMITTED

CLASS OF SERVICE: Telex | TELEX NO.: AA20836 | DATE: 2/13/87

SUBJECT: KENYA: Coal and Tea Studies

DRAFTED BY: RKhonsary:hm

EXTENSION: 72409

CLEARANCES AND COPY DISTRIBUTION:
cc: Wackman, Schramm, Newcombe (EAPEG)
Dosik, McBride, Broadfield (EGY).

AUTHORIZED BY (Name and Signature): Robin Bates, Acting Div. Chief, EGYS1

DEPARTMENT: EGY

SECTION BELOW FOR USE OF CABLE SECTION

CHECKED FOR DISPATCH

FORM NO. 27 - OCR (3/82)

WORLD BANK OUTGOING MESSAGE FORM Cable, Telex

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PAGE 1 OF 1

OFFICIAL DEPT/DIV ABBREVIATION: EGYS1

MESSAGE NUMBER:

TEST NUMBER (FOR CASHIER'S USE ONLY):

START HERE

MACDONALD WAGNER, SYDNEY, AUSTRALIA. ATTENTION MR. MALCOLM NICKLIN. RE: KENYA COAL AND TEA REPORTS. COPIES OF FINAL REPORTS RECEIVED, WITH THANKS. WILL NOW PROCEED TO ORGANIZE BANK REVIEW AND INFORM YOU OF RESULTS SHORTLY. HOPE YOU ARE RECOVERING WELL. BEST REGARDS, ROBIN BATES, ACTING DIVISION CHIEF, ENERGY STRATEGY AND PREINVESTMENT DIVISION I, WORLD BANK.

END OF TEXT

PINK AREA TO BE LEFT BLANK AT ALL TIMES

INFORMATION BELOW NOT TO BE TRANSMITTED

CLASS OF SERVICE: Telex	TELEX NO.: AA120836	DATE: 2/27/87
SUBJECT: KENYA: Coal and Tea Reports	DRAFTED BY: RBroadfield:hm	EXTENSION: 74031
CLEARANCES AND COPY DISTRIBUTION: cc: Messrs. McBride (EA1KU); Wackman, Schramm, Newsombe (EAPEG); Broadfield, Khonsary (EGY).	AUTHORIZED BY (Name and Signature): Robin Bates, Acting Div. Chief, EGYS1	
	DEPARTMENT: EGY	
	SECTION BELOW FOR USE OF CABLE SECTION	
	CHECKED FOR DISPATCH	

RECEIVED
1987 FEB 25 AM 5:54
CABLE SECTION

Macdonald Wagner

100 MILLER ST NORTH SYDNEY N.S.W. 2060 AUST.
- FACSIMILE TEL. No. - NATIONAL (02) 9576764
INTERNATIONAL +61 2 9576764

FACSIMILE TRANSMISSION FORM

INDICATE IF THIS FORM IS TO BE TRANSMITTED WITH DATA: Y

MESSAGE TO: ENERGY DIVISION - WORLD BANK, WASHINGTON

FACSIMILE TELEPHONE No.: 0011.1.202.4776391

ATTENTION: MR. ROBIN BATES/MR. ROBIN BROADFIELD ROOM D438

COPIES TO:

JOB No.: WBK101 DATE: 25/2/87 TIME SENT: (OPERATOR TO ENTER)

FOR SEPARATE PAGES SHEET SIZE: A4 B4 No OF SHEETS (INCLUDE THIS SHEET IN NUMBER): 4 Tx MODE:

NOTE: B4 SHEETS ARE REDUCED AUTOMATICALLY TO A4 SIZE DURING TRANSMISSION

FOR CONTINUOUS FEED LENGTH OF ROLL: METRES

HEADING OR REFERENCE: KENYA COAL AND TEA PROJECTS

MESSAGE: ROBIN/ROBIN/REZA

. FURTHER TO MY TELEX OF TODAYS DATE HEREWITH COPIES OF LETTERS OF TRANSMITTAL SENT WITH FINAL REPORTS TO YOU AND MOERD (NAIROBI) YESTERDAY.

. DOCUMENTS WERE SENT TO YOU VIA PANALPINA BY DIRECT INTERNATIONAL COURIERS PTY LTD AIRBILL NUMBER 05-247191.

. REGARDS TO ALL

PREINVESTMENT DIV. I
Dt. Recd. 3/6 Log No. 4515
For Action To: Broadfield
For Info. To:

Action Taken On: 3/9 File.
Reference File: Kenya Coal

FROM: MALCOLM NICKLIN, MACDONALD WAGNER

FACSIMILE MESSAGE
Please forward copy to the appropriate Information Center as necessary

Macdonald Wagner

Directors
V.B. Pullar B.E., F.I.E.Aust.
A.J. Denham B.E., F.I.E.Aust., M.Aust.I.M.M.
B.H. Anstey B.E., F.I.E.Aust.
M.K. Ballinger B.E., M.Eng.Sc., G.D.B.A., F.I.E. Aust.
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J.B. Corry A.S.T.C., F.I.E.Aust.
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P. Higgins B.E., M.I.E.Aust.
P.D. Isaacs B.E., M.I.E.M., F.I.E.Aust.
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P.A. Kearney B.E., M.Eng.Sc., M.I.E.Aust.
J.E. Machon B.E., M.I.E.Aust.
A.J. Mulch B.Sc. (Eng.), F.I.E.Aust., M.I.P.E.N.Z.
C.H. Tranberg B.E., M.Eng.Sc., Ph.D., F.I.E.Aust.
R.S. Warne B.Sc. (Eng.), M.I.C.E., M.I.E.Aust.

Macdonald Wagner Pty Limited
Engineers Managers
incorporated in New South Wales
Telephone (02) 929 5599
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Facsimile (02) 957 6764

Level 29 Northpoint Building
100 Miller Street North Sydney
PO Box 398 North Sydney
NSW 2060 Australia
Cables 'Macdas' Sydney
DX 10574 North Sydney

WBK101/MSN:CP
24 February 1987

Deputy Chief
Energy Assessments Division
World Bank
1818 H Street NW
WASHINGTON DC 20433
USA

Attention: Messrs. Robin Bates/Robin Broadfield/Reza Khonsary

Dear Sir,

Kenya Coal Conversion Action Plan
and
Kenya: Energy Efficiency in the Tea Industry

Further to our recent exchange of telexes and to the writer's telephone conversation with Mr Broadfield I have pleasure in enclosing copies of our Final Reports for the above projects as follows:

Bound copies of Volume 1 (Coal)	:	2 copies
Bound copies of Volume 2 (Coal)	:	2 copies
Bound copies of Volume 1 (Tea)	:	1 copy
Bound copies of Volume 2 (Tea)	:	1 copy
Unbound copies Volumes 1 & 2 (Coal)	:	(1 copy printed both sides (of each page ((1 copy printed one side (of each page
Unbound copies Volumes 1 & 2 (Tea)	:	(1 copy printed both sides (of each page ((1 copy printed one side (of each page
Covers Volume 1 & 2 (Coal)	:	(6 coloured covers and backs (for each volume ((9 white paper covers (for each volume

Covers Volume 1 & 2 (Tea)	:	(6 coloured covers and backs (for each volume ((9 white paper covers (for each volume
Flysheets Volumes 1 & 2 (Coal)	:	(15 on white paper (for each volume
Flysheets Volumes 1 & 2 (Tea)	:	(15 on white paper (for each volume

The unbound documents, covers and flysheets are to enable you, as arranged, to print and bind additional copies of the reports as may be required for your own uses and to provide Nairobi with any additional copies which may be required there.

I advise that I have today sent to Mr.S.A.R. Bagha of the Ministry of Energy and Regional Development, Nairobi three (3) bound copies of each volume of each report, again as requested by Mr. Broadfield. I refer you particularly to the third paragraph of my letter of today's date to MOERD, copy enclosed.

I would be grateful if you would acknowledge by telex receipt of all the documents sent with this advice. Our final accounts for our services provided for these two projects will be sent in mid March 1987 to Mr. Bagha in Nairobi for his certification and passing on to you for payment.

On behalf of my project team and myself I wish to add that we have all found the projects very interesting indeed and we do sincerely hope that Kenya's energy situation will be improved as a result of our efforts.

With personal regards to you all.

Yours sincerely,
MACDONALD WAGNER PTY. LIMITED

Malcolm S. Nicklin
Director and Team Leader

Macdonald Wagner

Macdonald Wagner Pty Limited
Engineers Managers
Incorporated in New South Wales
Telephone (02) 929 5599
Telex AA120836
Facsimile (02) 957 6764

Level 20 Northpoint Building
100 Miller Street North Sydney
PO Box 590 North Sydney
NSW 2060 Australia
Cables 'Macdas' Sydney
DX 10574 North Sydney

WBK101/MSN:CP
24 February 1987

Permanent Secretary
Ministry of Energy & Regional Development
PO Box 30582
NAIROBI
KENYA

Attention: Messrs. P.M. Nyoike/S.A.R. Bagha

Dear Sir,

Kenya Coal Conversion Action Plan
and
Kenya: Energy Efficiency in the Tea Industry

I refer to letter dated 16th January, 1987 from my colleague Mr. Martin thomas and to our recent exchange of telexes.

I now have pleasure in enclosing three (3) bound copies each of Volumes 1 and 2 of the Final Report for each of the above projects. I would be gratefull if you would send one set of the "Tea" report to the KTDA just as soon as you have received it, as arranged with Mr. Robin Broadfield of the World Bank.

A copy of my letter of today's date to the World Bank is enclosed for your information. Should you require further copies of the Final Reports for these projects you will be able to obtain them from Mr. Broadfield of the World Bank, Washington.

Please acknowledge by telex when you have received these bound final reports and have passed one set of the Tea Industry report to KTDA.

On behalf of my project team and myself I wish to add that we have all found the projects very interesting indeed and we do sincerely hope that Kenya's energy situation will be improved as a result of our efforts.

With personal regards to you all.

Yours sincerely,
MACDONALD WAGNER PTY. LIMITED

Malcolm S. Nicklin

Malcolm S. Nicklin
Director and Team Leader

MERZ & McLELLAN & PARTNERS
Engineers and Project Managers

PARTNERS
IAN W. STEELE (Senior) MARTIN H. THOMAS
PETER J. FENTON DAVID L. A. HUNTER
HUGH W. BAILEY KEITH M. YOUNG

ASSOCIATES
CAMPBELL P. ADAM ROBERT B. BRAYSHAW
COLIN J. GOSLING MICHAEL W. REID
DEREK O. FERN PETER W. VAUGHAN

SECRETARY
NEIL M. HONNOR

CONSULTANT
D. BRYNMOR EVERETT

MANAGER – NSW OPERATIONS
PETER W. VAUGHAN

5 HARBOUR VIEW CRESCENT, MILSONS POINT,
N.S.W. 2061, AUSTRALIA
POSTAL ADDRESS: PRIVATE BAG 820, MILSONS POINT, N.S.W. 2061

TELEPHONE: (02) 922 2666
TELEGRAMS: AMBERSD SYDNEY
TELEX: AA121126
FACSIMILE: (02) 957 1474

ALSO
BRECON, 47 COLIN STREET, WEST PERTH, W.A. 6005 TEL (09) 322 2433 TELEX AA92311 FACS (09) 325 5972
11 QUEENS ROAD, MELBOURNE, VIC, 3004 TEL (03) 266 2524 TELEX AA30930 FACS (03) 267 1046
127 CREEK STREET, BRISBANE, QUEENSLAND, 4000 TEL (07) 229 6911 TELEX AA121126 FACS (07) 229 6249
47 KNUCKEY STREET, DARWIN, N.T. 5790 TEL (089) 81 4433 TELEX AA85471 FACS (089) 81 5946
3 BROOKE STREET, HOBART, TASMANIA, 7000 TEL (002) 34 9717 TELEX AA121126 FACS (002) 23 4291

Your Ref:
Our Ref: 624:01
MHT/JK

26 September 1986

Attention Messrs: R Bates/R Broadfield/
R Khonsary

Energy Strategy & Preinvestment Division II
Date Received: 9/29
Project Name:
Project Officer: ~~Broadfield~~ Files
#678
Date Action Taken: 3/9/87

Deputy Chief,
Energy Assessments Division,
World Bank
1818H Street NW,
WASHINGTON DC 20433,
USA

Dear Sirs

KENYA: COAL CONVERSION ACTION PLAN
Final Energy Audit Reports

In accordance with our undertakings as confirmed in telexes with you, we have pleasure in submitting one copy of each of the further Energy Audit Reports listed in Attachment A.

Our understanding is that these reports will now be printed and bound by the Bank, and be issued to recipients within the Bank, within the Ministry of Energy and Regional Development, Nairobi, and of course within the organisations audited.

We would suggest that, from discussions with those organisations, a minimum of four copies would be required.

.../2

GEOFFREY G. R. ARGENT ALEXANDER J. RENNIE CHARLES G. HOPPER TERENCE A. C. DULLEY
PETER KNOWLES THOMAS E. NORRIS MALCOLM W. KENNEDY MICHAEL L. CUNLIFFE

Since the Ministry of Energy will no doubt wish to have several copies. You may feel that the question of the number of copies to be printed is best resolved at our meetings in Nairobi.

Finally we should mention that copies would be appreciated by the Consultant team since one copy only has been retained by Merz & McLellan & Partners in the meantime.

The reports have been sent to you as individual clean sheets with all pages numbered. The convention we should like you to follow is that all odd numbered pages shall be printed for binding on the right hand side of each book, with even numbers to the left. Since each report contains a number of common Appendices, as listed in the Table of Contents for each report, we are sending one master copy only of each to avoid multiple printing at this end.

With regard to the Ministry of Energy and Regional Development we have, at your request, sent a further two copies of the final draft of each Energy Audit Report, but in this case, the reports have already been printed on both sides of the paper and spiral bound, as with the first drafts that were sent to Nairobi for comment.

We trust that the above printing and despatch arrangements meet with your approval.

Yours faithfully

MARTIN THOMAS

Enc. Attachment A

ATTACHMENT A

Factory	District
Madhupaper International Ltd	Nairobi, Kenya
Emco Steel Works Ltd	Nairobi, Kenya
Kenya Meat Commission	Athi River, Kenya
East African Sugar Industries Ltd	Muhoroni, Kenya
Bamburi Portland Cement Co Ltd	Mombasa, Kenya
East African Portland Cement	Nairobi, Kenya
Kenya Co-operative Creameries Ltd	Kitale, Kenya
Rift Valley Textiles Ltd	Eldoret, Kenya
Oil Extraction Ltd	Nairobi Kenya
Thika Cloth Mills Ltd	Thika, Kenya

MERZ & McLELLAN & PARTNERS
Engineers and Project Managers

MERZ AUSTRALIA

PARTNERS
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MANAGER – NSW OPERATIONS
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N.S.W. 2061, AUSTRALIA
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TELEPHONE: (02) 922 2666
TELEGRAMS: AMBERSD SYDNEY
TELEX: AA121126
FACSIMILE: (02) 957 1474

ALSO
BRECON, 47 COLIN STREET, WEST PERTH, W.A. 6005 TEL (09) 322 2433 TELEX AA92311 FACS (09) 325 5972
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3 BROOKE STREET, HOBART, TASMANIA, 7000 TEL (002) 34 9717 TELEX AA121126 FACS (002) 23 4291

Your Ref:
Our Ref: 624:01
MHT/JK

8 October 1986

Energy Strategy & Preinvestment Division II
Date Received: 10/10
Project Name:
Project Officer: ~~Broadfield~~ RKes.
#709
Date Action Taken:

Attention Messrs: R Bates/R Broadfield/
R Khonsary

Deputy Chief,
Energy Assessments Division,
World Bank
1818 H Street NW,
WASHINGTON DC 20433,
USA

Dear Sirs

KENYA: COAL CONVERSION ACTION PLAN
Final Energy Audit Reports

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We would suggest that, from discussions with those organisations, a minimum of four copies would be required.

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Finally we should mention that copies would be appreciated by the Consultant team since one copy only has been retained by Merz & McLellan & Partners in the meantime.

The reports have been sent to you as individual clean sheets with all pages numbered. The convention we should like you to follow is that all odd numbered pages shall be printed for binding on the right hand side of each book, with even numbers to the left. Since each report contains a number of common Appendices, as listed in the Table of Contents for each report, we are sending one master copy only of each to avoid multiple printing at this end.

With regard to the Ministry of Energy and Regional Development we have, at your request, sent a further two copies of the final draft of each Energy Audit Report, but in this case, the reports have already been printed on both sides of the paper and spiral bound, as with the first drafts that were sent to Nairobi for comment.

We trust that the above printing and despatch arrangements meet with your approval.

Yours faithfully

pp

MARTIN THOMAS

Enc. Attachment A

ATTACHMENT A

Factory	District
Magadi Soda Co	Magadi, Kenya
Kenya Glass Works Limited	Mombasa, Kenya
Panafrican Paper Mills	Webuye, Kenya
Clayworks Limited	Nairobi, Kenya
Kenya Breweries Limited	Nairobi, Kenya
Kenyatta National Hospital	Nairobi, Kenya
Kenya Calcium Products Limited	Thika, Kenya
B.A.T Kenya Limited	Nairobi, Kenya
Kaluworks Limited	Mombasa, Kenya
Firestone East Africa Limited	Nairobi, Kenya
Kenya Canners Limited	Thika, Kenya

Master - Appendix B
- Appendix C
- Appendix D
- Appendix E
- Appendix G
- Appendix H
- Appendix I

624:01
MHT:JK 8 October 1986

Attention: Mr P N Nyoike/Mr S A R Bagha

Ministry of Energy and Regional
Development
Room 2110, Floor 21
Nyayo House
Nairobi
KENYA

Dear Sirs

KENYA: COAL CONVERSION ACTION PLAN
Final Energy Audit Reports

We have pleasure in enclosing two bound final copies of each of the Energy Audit Reports listed on Attachment A. The purpose of these reports is to assist in the meeting to be held in Nairobi with the Bank and ourselves in the week beginning Monday 13 October, 1986.

.../2

In due course, the full complement of copies of each Energy Audit Report will be prepared by the World Bank and distributed in quantities yet to be determined, but which will be sufficient to cover the needs of the Ministry and of each of the organisations audited.

With regard to the Energy Audit Reports, you should note that the differences between the current issues, and the previous final drafts sent for comment is in most cases very limited, amounting to minor corrections only and attention to issues raised by those organisations in Kenya who submitted comments through the Ministry.

We trust that the Energy Audit Reports will prove to be a useful and significant addition to your ongoing energy management initiatives in Kenya, and trust that we may be associated with you in ongoing work in this sector.

Yours faithfully

M H THOMAS

Enc. Attachment A

CC Messrs: R Bates/R Broadfield/R Khonsary - World Bank, Washington
Mr M S Nicklin - Macdonald Wagner Pty Ltd
Mr J A Spence/Dr A O'Malley - Coopers & Lybrand W D Scott

ATTACHMENT A

Factory	District
Magadi Soda Co	Magadi, Kenya
Kenya Glass Works Limited	Mombasa, Kenya
Panafrican Paper Mills	Webuye, Kenya
Clayworks Limited	Nairobi, Kenya
Kenya Breweries Limited	Nairobi, Kenya
Kenyatta National Hospital	Nairobi, Kenya
Kenya Calcium Products Limited	Thika, Kenya
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Firestone East Africa Limited	Nairobi, Kenya
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MHT:JK 29 September 1986

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Development
Room 2110, Floor 21
Nyayo House
Nairobi
KENYA

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Yours faithfully

M H THOMAS

Enc. Attachment A

CC Messrs: R Bates/R Broadfield/R Khonsary - World Bank, Washington
Mr M S Nicklin - Macdonald Wagner Pty Ltd
Mr J A Spence/Dr A O'Malley - Coopers & Lybrand W D Scott

ATTACHMENT A

Factory	District
Madhupaper International Ltd	Nairobi, Kenya
Emco Steel Works Ltd	Nairobi, Kenya
Kenya Meat Commission	Athi River, Kenya
East African Sugar Industries Ltd	Muhoroni, Kenya
Bamburi Portland Cement Co Ltd	Mombasa, Kenya
East African Portland Cement	Nairobi, Kenya
Kenya Co-operative Creameries Ltd	Kitale, Kenya
Rift Valley Textiles Ltd	Eldoret, Kenya
Oil Extraction Ltd	Nairobi Kenya
Thika Cloth Mills Ltd	Thika, Kenya

Macdonald Wagner

Macdonald Wagner Pty Limited
Engineers Managers
Incorporated in New South Wales
Telephone (02) 929 5599

Level 29 Northpoint Building
100 Miller Street North Sydney
PO Box 398 North Sydney
NSW 2060 Australia

Telex AA 120836

Cables 'Macdas' Sydney

DX 10574 North Sydney

WBK101:MSN:CP
23 March 1987

cc Mr. Dosik
Mr Bates
Mr. Broadfield

Deputy Chief
Energy Assessments Division
World Bank
1818 H Street NW
WASHINGTON DC 20433 USA

Attention: Messrs. Robin Bates/Robin Broadfield/Reza Khonsary

Dear Sir,

Kenya: Energy Efficiency in the Tea Industry
Final Progress Report No. 13/19 - September 1986 to March 1987

In accordance with our contract for the above assignment, we enclose herewith our Final Progress Report No. 13/19 - September 1986 to March 1987.

A copy of the report has been sent today to Mr. P.M. Nyoike of the Kenyan Ministry of Energy and Regional Development.

Yours faithfully,
MACDONALD WAGNER PTY. LIMITED

M S Nicklin

per: M.S. Nicklin
Director and Team Leader

encl.

Macdonald Wagner

THE GOVERNMENT OF KENYA

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

KENYA: ENERGY EFFICIENCY IN THE TEA INDUSTRY

FINAL PROGRESS REPORT NO. 13/19

SEPTEMBER, 1986 TO MARCH, 1987

Macdonald Wagner Pty. Limited
Consulting Engineers
100 Miller Street
NORTH SYDNEY NSW
AUSTRALIA 2060

23 March 1987

KENYA: ENERGY EFFICIENCY IN THE TEA INDUSTRY

FINAL PROGRESS REPORT NO. 13/19 - SEPTEMBER 1986 TO MARCH 1987

CONTENTS:

1.0 INTRODUCTION

By arrangement with the World Bank the monthly reports September, 1 to February, 1987 were not prepared. During the early part of period the modified draft final report issued in August 1986 examined by the World Bank prior to the mid-October meetings in Nair following which some sensitivity analyses were re-run and seve chapters and appendixes of the report were subjected to major editor changes.

The final reports were issued to the World Bank, MOERD, KTDA and A on 24th February, 1987. The final account for payment for Consultant's professional services was rendered on 20th March, 1987.

The 19 Tea Factory Audit Reports were issued to KTDA, for on-passing the relevant factory, in September, 1986. A single page caveat issued for addition to each report in January 1987 following re-working of the sensitivity analyses referred to above.

2.0 CONTRACT

There has been no change to the contractual arrangements between World Bank and the Consultants since the last report which was dated August, 1986.

3.0 PROVISION OF CONSULTANT'S OFFICE AND TRANSPORT

The Consultants' team did not operate in Nairobi during the per September 1986 to March 1987 except for the October 1986 rev meetings, however Mr. S.A.R. Bagha of MOERD continued to incur expen (airfreight and telex) on behalf of the Consultants. He, and MOE have been fully reimbursed for all costs incurred.

4.0 PROJECT FEES AND EXPENSES

Payment of the account for services rendered by the Consultants during the period February, March, April 1986 ($6,543.59 modified f $14,356.72 after consultation with the World Bank late in May 1986) not received until October, 1986, just a few days only prior to commencement of the final review meetings in Nairobi - a m unsatisfactory situation.

The final account for fees and reimbursable expenses was issued on 2 March, 1987. Prompt payment of the account by the World Bank requested.

The situation for fees and expenses incurred as at the completion the project is repeated hereunder:

	APPENDIX C5 A$	APPENDIX D1 A$	TOTAL A$
September 1985	48,271.54	15,859.11	64,130.65
October 1985	58,122.12	14,856.15	72,978.27
November 1985	27,095.48	3,240.20	30,335.68
December 1985	8,661.24	6,074.15	14,735.39
January - March 1986	4,943.19	756.40	5,699.59
April 1986 to March 1987	14,210.87	909.55	15,120.42
	161,304.44	41,695.56	203,000.00

The final cost as billed was $203,000.00. However, to properly indicate the final cost of the project some $50,000.00 should be added to indicate the time and expense actually incurred by the project team to bring the energy audits, the economic and financial analysis and the final reporting to the standard finally agreed by the World Bank, MOERD, KTDA and the Consultants. ?

5.0 PERSONNEL MOVEMENTS

Messrs. Malcolm Nicklin and Martin Thomas travelled to Nairobi (and in the case of Mr. Thomas, Washington) during the month of October 1986 for final meetings with the client body. Dr. D.A. O'Malley travelled from his home in Adelaide to Sydney twice during the period covered by this report to work with the project team.

6.0 STEERING COMMITTEE

The Committee did not meet during the period September 1986 to March 1987.

7.0 MEETINGS, VISITS, INSPECTIONS

Many team meetings were held during the period covered by this report and the final formal meetings attended by all relevant parties were held in Nairobi from Monday 13th to Friday 17th October, 1986.

8.0 ENERGY AUDITS

There was no action relating to this matter during the period.

9.0 TEA FACTORY ENERGY AUDIT PROGRAMME

The final edition of the 19 individually bound comprehensive audit reports were issued to all parties in September, 1986 with the caveats referred to above issued in January, 1987.

10.0 INSTITUTIONAL AND INFRASTRUCTURE REQUIREMENTS

The re-editing of the appropriate sections of the main report and the appendices was completed and incorporated into the final edition of the two volumes prior to their issue in February, 1987.

11.0 ECONOMIC AND FINANCIAL REQUIREMENTS

The re-editing of the appropriate sections of the main report and the appendices was completed and incorporated into the final edition of the two volumes prior to their issue in February, 1987.

12.0 CONCLUSION

The project is now complete in all respects and the receipt of the final reports has been acknowledged by the World Bank and the MOERD.

Malcolm S. Nicklin
Team Leader

23 March 1987

THE WORLD BANK / INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

DATE April 7, 1987

TO Ms. Susana Hristodoulakis, Budget Analyst, EGYHE

FROM Reza Khonsary, EGYHE RK

EXTENSION 72409

SUBJECT Kenya: Energy Efficiency in the Tea and Coal Conversion Action Plan - Settlement of the Consultant's Final Invoices

1. Please find attached the final Government approved invoices for Aus. $25,034.76 from Macdonald Wagner, Pty., for the consultancy services provided for the months of May 1986 to February 1987, for the above studies.

2. The Consultants, in their monthly report to us, have made a special request for the immediate settlement of their invoices.

3. The payment of these invoices completes the Bank's obligation under our contract with Macdonald Wagner for both Tea and Coal studies.

4. Would you please arrange for the payment of these invoices as soon as the "freeze" is lifted, which I understand will be before the end of this week?

5. I am informed by Mr. Herbert Langer, LOATF, that there is also a deficit of $13,611.81 in the Trust Fund for the above projects as a result of the payments already made. This must be covered from ESMAP resources as well.

Attachment

cw & cc: Mr. Broadfield (EGYES)

cc: Messrs. Dosik (EGYHE), Montfort, Bates (EGYES)
Ms. Walsh (EGYES)

RKhonsary:js

P-1866

ENERGY STRATEGY AND PREINVESTMENT DIV. I

Dt. Recd. 4/8 Log No. 4789

For Action To: Broadfield

For Info. To: ~~Hartgook~~ ~~Bates~~

Action Taken On: 4/13

Reference File: Kenya Coal n Tea

ZCZC DIST3552 RCA1420
EGYS1 EGYS2
REF : TCP1 MET
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* EGYS1 *
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RCA1420
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MACDAS AA24204

MACDAS AA120836
APC301/96/080487/0248 PM

TELEX TO : WORLD BANK WASHINGTON
ATTENTION: MESSRS. ROBIN BATES/ROBIN BROADFIELD/REZA KHONSARY
ENERGY ASSESSMENTS DIVISION EGY&2
WORLD BANK WASHINGTON (ROOM D438)

FROM : MALCOLM NICKLIN
MACDONALD WAGNER

RE : KENYA COAL AND TEA PROJECTS

AA) THANKS FOR TELEXED AKNOWLEDGEMENT RECEIPT OF FINAL REPORTS FOR BOTH PROJECTS.

BB) I HAVE BEEN INVITED TO PARTICIPATE IN A 6 MAN (CONSULT AUSTRALIA/AUSTRADE) MISSION TO EAST AFRICA 26 APRIL - 22 MAY SYDNEY TO SYDNEY.

CC) AFTER VISIT TO AFRICAN DEVELOPMENT BANK IN ABIDJAN MISSION ARRIVES NAIROBI SATURDAY MORNING 2 MAY AND DEPARTS FOR MOGADISHU

SUNDAY AFTERNOON 10 MAY. THENCE ADDIS ABABA, DAR ES SALAAM AND LUSAKA BEFORE TRANSIT HARARE FOR SYDNEY. ALSO IN NAIROBI AFTERNOON AND NIGHT WEDNESDAY 13 MAY.

DD) NATURALLY I WILL MEET WITH MOERD AND KTDA WHILE IN NAIROBI. MISSION WILL ALSO MEET WORLD BANK NAIROBI OFFICE.
IS THERE A POSSIBILITY THAT SOMEONE FROM YOUR DIVISION WHO WAS INVOLVED WITH OUR TWO PROJECTS WILL BE IN NAIROBI, THE WEEK I AM

THERE, IF SO SURELY ONLY GOOD COULD COME FROM OUR MEETING UP THEN.

I am afraid not

EE) I WOULD BE MOST GRATEFUL FOR YOUR EARLY TELEXED REPLY/COMMENT ON

ITEM DD ABOVE.

FF) I VISIT MACDONALD WAGNERS OFFICE RE: THE MISSION EVERY SECOND MORNING AFTER PHYSIOTHERAPY FOR MY UPPER ARM/SHOULDER MUSCLES WHICH ARE STILL FAR FROM OK ALTHOUGH THE BROKEN BONE HAS KNIT SUCCESSFULLY.

GG) REGARDS TO ALL.

REGARDS
MALCOLM NICKLIN
MACDONALD WAGNER

THE WORLD BANK/INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

DATE: April 10, 1987

TO: Messrs. Gunter Schramm, EAPEG, and George McBride, AE1KU

FROM: Robin Broadfield, EGYES, and Reza Khonsary, EGYHE

SUBJECT: ESMAP: KENYA - Consultants Reports on: (a) Coal Conversion, Energy Conservation and Substitution Action Plan; and (b) Energy Efficiency in the Tea Industry

1. Attached are the consultant's final reports on the above two activities, together with draft forewords prepared by us.

2. The reports are a considerable improvement on earlier drafts. Sensitivity tests and economic analysis for a range of fuel prices have been added. The discussion of Kenyan energy conservation policy has been strengthened and the public sector institutional proposals trimmed back to a level appropriate to Kenyan conditions.

3. It is our intention to issue the reports as consultants documents under an ESMAP white cover for distribution to interested donor agencies. Your clearance to proceed is requested.

Cleared with and cc: Mr. B. Montfort (EGYES)
cc & w/o attachment: Messrs. Wackman, Newcombe (o/r) (EAPEG); Amoako (EA1); Dosik (o/r) (EGYHE)

ARBroadfield:tlha

P-1867

FOREWORD

The Energy Assessment report on Kenya 1/, issued in May 1982, identified the country's dependence on costly imported energy as one of two major issues in the energy sector, the other being deforestation and the consequent decline in fuelwood supply. Subsequently, the Government of Kenya requested assistance from the Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) to evaluate the potential for increasing the efficiency of energy use in the industrial sector and in the tea industry, two major consumers of imported fuels. This evaluation was to include both measures to conserve on the use of energy and to substitute less costly fuels, including imported coal and indigenous biomass fuels.

This report, and a companion document "Kenya Coal Conversion, Energy Conservation and Substitution Action Plan", present the results of that evaluation. The reports were prepared by a team of consultants, led by the firm of Macdonald Wagner, in association with Merz and MecLellan and Partners, Gavan McDonell and Company, Coopers and Lybrand W.D. Scott, Forestry Technical Services Pty. Ltd and I.A. Gilmour of the University

---

1/ "Kenya: Issues and Options in the Energy Sector" Report no. 3800KE of the Joint UNDP/World Bank Energy Sector Assessment Program, May 1982.

of Canterbury, New Zealand. Funding for the bulk of the consultants' services was provided by a grant from the Australian Development Assistance Bureau. The consultants were supervised jointly by ESMAP staff and the Government of Kenya.

Two points should be noted about the report. First, it is based on analyses of energy conservation and substitution options performed in 1985, prior to the collapse in world oil prices. Second, average biomass fuel costs, not location-specific supply and cost estimates, were used for the prefeasibility analysis of potential biomass substitution projects. The consultants' findings must therefore be interpreted in the light of these facts before projects are selected for feasibility analysis. This requires: (a) use of the report's fuel price sensitivity tests and economic fuel cost analysis to screen potential conservation and substitution investment projects for consistency with expected future energy prices and economic costs; and (b) identification and costing of specific fuelwood and/or other biomass fuel supplies for each project involving the substitution of fuelwood or other biomass for conventional fuels.

The report presents the consultants' findings and does not necessarily represent the views of either the Government of Kenya, the UNDP or the World Bank. It has been distributed to the Kenyan authorities and to selected donor agencies. Further copies are available on request.

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Joint UNDP/World Bank
Energy Sector Management Assistance Program

KENYA

COAL CONVERSION, ENERGY CONSERVATION AND SUBSTITUTION ACTION PLAN

A REPORT BY CONSULTANTS

APRIL 1987

Energy Efficiency and Strategy Division
Energy Department
The World Bank
Washington, D.C. 20433

Joint UNDP/World Bank
Energy Sector Management Assistance Program

KENYA

ENERGY EFFICIENCY IN THE TEA INDUSTRY

A REPORT BY CONSULTANTS

APRIL 1987

Household Energy Division
Energy Department
The World Bank
Washington, D.C. 20433

PREINVESTMENT DIV. I

Dt. Recd.

Reference File:

WDIAL
.EGYS2
OINFO

-SUBJECT: MEETING IN NAIROBI AND COAL AND TEA REPORTS
-DRAFTED BY: RKHONSARY:JAS EXT: 72409
-AUTHORIZED BY: R. BATES, DEPUTY CHIEF, EGYES
-CW AND CC: MESSRS. BROADFIELD, SCHRAMM
-CC: MESSRS. MONTFORT (EGYES), DOSIK O/R TERRADO (EGYHE), WACHMAN,
-NEWCOMBE (EAPEG), MCBRIDE (EAI)

---

790 120836 =
-ATTN: MR. MALCOLM NICKLIN
-MACDONALD WAGNER
-SYDNEY, AUSTRALIA
BT
WASHINGTON, D.C. 13-APR-87
RE: YOUR TELEX OF APRIL 8, 1987.
THERE IS A POSSIBILITY THAT MR. GUNTER SCHRAMM WILL BE IN NAIROBI DURING THE 1ST WEEK OF MAY TO ATTEND THE REVIEW MEETING OF POWER SECTOR MASTER PLAN FINAL REPORT.
WE HAVE INFORMED HIM OF YOUR MISSION TO NAIROBI AND HE HAS AGREED TO MEET WITH YOU AND YOUR COLLEAGUES.
PLEASE CONTACT WORLD BANK NAIROBI OFFICE ON ARRIVAL TO CONFIRM THAT HE HAS ARRIVED IN NAIROBI AND TO ARRANGE FOR A MUTUALLY CONVENIENT TIME.
REGARDING THE TEA AND COAL REPORTS, WE ARE IN THE PROCESS OF DECIDING ON THE FORM IN WHICH THESE REPORTS WILL BE DISTRIBUTED.
WE ARE HAPPY TO KNOW THAT YOU HAVE COMPLETELY RECOVERED. WITH BEST WISHES ROBIN BATES, DEPUTY DIVISION CHIEF, ENERGY EFFICIENCY AND STRATEGY DIVISION, ENERGY DEPARTMENT, WORLD BANK.

THE WORLD BANK / INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

DATE: June 22, 1987

TO: Distribution

FROM: Richard Dosik, Division Chief, EGYHE

EXT: 72051

SUBJECT: ESMAP: KENYA: Energy Efficiency in the Tea Industry

1. Attached please find a copy of Volumes I and II of the final consultants' report of this ESMAP-managed activity.

2. The report evaluates the scope for reducing energy consumption in the tea industry, which was identified in the Kenya Energy Assessment report as a large user of process energy with considerable conservation potential. It is based on the results of 19 plant energy audits, covering half the state-owned tea factories in the country.

3. The report identifies considerable scope for improving energy efficiency through no or low cost "housekeeping" measures. It also identifies potential small-scale investment projects to replace inefficient combustion equipment and, where adequate supplies are available, to substitute fuelwood for fuel oil. A tea industry energy management program is proposed to help translate the reports' recommendations into concrete action.

4. Comments or questions on the report should be addressed to Reza Khonsary (Ext. 72409).

Attachment

Distribution

Messrs. Kopp, Raphaeli (PPD); Dubey (CPD); Willoughby (EDI); Richardson (CDD); Kuczynski (CENVP); Spears, Greenwood (AGR); Chopra (OED); Bennathan (TRP); Isenman (ESAVP); Poortman, Amoako, McBride, Jones (EA1); Madavo, Gusten, Wackman, Schramm, Newcombe, Telahun (EAP); Mckechnie (EMPPE); Golan, Colaco, de Capitani, Gamba, Goldberg, Raghavan, Rowat, Stern (IND); Churchill, Saunders, Fish, Heron, Iskander, Bates, Broadfield, Khonsary (EGY); Rothermel/Cox (UNDP, New York); Adams (World Bank Res. Rep., Nairobi, Kenya); Pennacchio (UNDP Res. Rep., Nairobi, Kenya).
Mmes. Johansen (TRP); Adu (LEG).

EGYES/EGYHE Higher Lever Staff (Attachment available on request).

RKhonsary:vwm

P-1867

Kenya - Tea Industry Energy Efficiency subject

WDIAL
.EGYS2
OINFO

-SUBJECT: KENYA ESMAP COAL CONVERSION, ENERGY CONSERVATION AND
- SUBSTITUTION ACTION PLAN AND KENYA ENERGY EFFICIENCY IN
- THE TEA INDUSTRY REPORTS
-DRAFTED BY: RKHONSARY/JAS EXT: 72409
-AUTHORIZED BY: RICHARD S. DOSIK, CHIEF, EGYHE
-CW AND CC: BROADFIELD (EGYES), SCHRAMM (EAPEG), OFOSU-AMAAH (LEGVP)
-CC: MONTFORT O/R, BATES O/R (EGYES), WACKMAN (EAPEG), ARMAR (EGYHE)

---

790 AA120836 =
-ATTN: MR. BRETT JOBSON, DIRECTOR
-MACDONALD WAGNER
-SYDNEY, AUSTRALIA
BT
WASHINGTON, D.C. 15-MAY-87
THANK YOU FOR YOUR TELEX OF MAY 12, 1987, IN WHICH YOU CONFIRM THAT THE COPYRIGHT ON TEA AND COAL REPORTS IS NOT VESTED IN THE CONSULTANTS. WE READ THIS TO MEAN ALL CONSULTANTS AND FIRMS ASSOCIATED WITH THE PREPARATION OF THE TWO REPORTS, INCLUDING MACDONALD WAGNER. IN ADDITION, WE EXPECT THAT YOU HAVE TAKEN MEASURES TO REPLACE THE COVER PAGES OF THE TWO REPORTS TO INDICATE WHO HAS THE COPYRIGHT. FURTHER, SINCE SOME OF THESE REPORTS HAVE BEEN DISTRIBUTED, WE EXPECT YOU TO NOTIFY THE RECIPIENTS IN WRITING THAT PURSUANT TO YOUR AGREEMENT WITH THE BANK, SAID REPORTS SHALL NOT BE USED FOR PURPOSES UNRELATED TO THE PROJECT WITHOUT PRIOR WRITTEN APPROVAL OF THE GOVERNMENT OF KENYA AND THE BANK. REGARDS, REZA KHONSARY, HOUSEHOLD ENERGY DIVISION, ENERGY DEPARTMENT, WORLD BANK.

Z

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WDIAL
REF : EGYS2
OINFO

-SUBJECT: KENYA ESMAP COAL CONVERSION, ENERGY CONSERVATION AND
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-DRAFTED BY: RKHONSARY/JAS EXT: 72409
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-CC: MONTFORT O/R, BATES O/R (EGYES), WACKMAN (EAPEG), ARNAR (EGYHE)

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=05151533

IN DROPCOPY OF:YS2R

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ZCZC YS2N0330 OPER2554
QX DELMSG
REF : SYSCOM

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Joint UNDP/World Bank
Energy Sector Management Assistance Program

KENYA

ENERGY EFFICIENCY IN THE TEA INDUSTRY

VOLUME II - APPENDICES

A REPORT BY CONSULTANTS

MAY 1987

Household Energy Division
Energy Department
The World Bank
Washington, D.C. 20433

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GLOSSARY OF TERMS

APPENDIX A - GLOSSARY OF TERMS

Units used throughout this report conform to the System Internationale (SI) using the following standard abbreviations and conversion factors. Where other units are used they are explained in the text.

Abbreviations	Meaning
GOK	Government of Kenya
ADAB	Australian Development Assistance Bureau
IBRD	World Bank (International Bank for Reconstruction and Development)
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
KPLC	Kenya Power and Lighting Company
KTDA	Kenya Tea Development Authority
MOERD	Ministry of Energy and Regional Development
UNDP	United Nations Development Programme
Consultants	Macdonald Wagner Pty Ltd in association with Merz & McLellan & Partners, Gavan McDonnell and Company, Coopers & Lybrand W D Scott (formerly W D Scott & Co), Forestry Technical Services Pty Ltd, and I.A. Gilmour, University of Canterbury, N.Z.

Terms	Meaning
Target 1 (Short Term)	Energy savings target achievable, based on conservation measures which could be taken almost immediately with minimum engineering input and, in general, minimum capital investment. Typically, such measures would show a simple payback of under one year and would include basic house-keeping and correct operating and maintenance practices.
Target 2 (Long Term)	Energy savings target achievable based on conservation measures which could be taken, with appropriate planning and engineering input and the expectation of capital investment in new or improved plant or processes or a more economic energy source, and which would give an acceptable economic and financial rate of return, (i.e. greater than 15% real).
Energy Intensity	The ratio of energy consumption to production, typically expressed in units of gigajoules per tonne of product (GJ/t). Also referred to as specific energy consumption.
GSE	Gross Specific Energy, measured in GJ/t. GSE is used throughout this report. Net Specific Energy may be obtained by subtracting the latent heat of vaporisation of water formed in the combustion reaction, which is a function of the hydrogen content of the unburnt fuel. Typically, the ratio Net/Gross Specific Energy is about 0.94 for RFO and 0.98 for coal.
FY 1985	Financial Year (1 July 1984 - 30 June 1985).
CY 1985	Calendar Year (1 January 1985 - 31 December 1985).
mcwb	Moisture content wet basis
OD	Oven dry
AD	Air dry

Terms	Meaning
Fuelwood	Any combustible woody material, e.g. from trees, shrubs, coffee husks, etc.
Wood	Fuelwood from trees
Load factor	Ratio of average electricity demand to maximum demand.
MD	Maximum demand, expressed as kVA, is the highest rate of electricity energy usage in any twenty minute interval during the meter reading period, which is typically 30 days.
Maji Abiria	Moisture entering with dryer inlet air and causing a loss of efficiency, literally meaning in Kiswahili "a passenger". (Normal English usage - "tramp moisture".)
Hewa Abiria	Air leakage into a furnace which serves no purpose and causes a loss of efficiency.
MT	Made tea, i.e. final product.
GL	Green leaf, as plucked and sold to the factory.
LPG	Liquified Petroleum Gas
GLN	Gasoline (petrol)
IDO	Industrial Diesel Oil
RFO	Refinery Fuel Oil
GAO	Gas Oil
FBD	Fluidised bed dryer
ECD	Extended Chain dryer, or tray dryer.

Units	Meaning
A	Amps (electrical current)
V	Volts (electrical pressure)
kV	kilovolts = 10^3V
W	Watt (electric power)

Units	Meaning
kW	kilowatts = 10^3W
kVA	kilovolt Amp
kVAr	kilovolt Amp (reactive)
kWh	kilowatt hours = 3.6 MJ
MWh	Megawatt hours = 10^3 kWh = 3.6 GJ
bar	bar (pressure)
kPa	kilopascals (pressure)
J	Joule (energy) = 1W.s
kJ	kilojoule = 10^3 Joules
MJ	Megajoule = 10^6 Joules
GJ	Gigajoule = 10^9 Joules = 278 kWh
TJ	Terajoule = 10^{12} Joules
kg	kilogram (mass)
t	tonne = 10^3 kg
L	Litre (volume)
kL	kilolitre = 10^3 L = $1m^3$
ML	Megalitre = 10^6 L = 1000 m^3
cp	centipoise (viscosity)
s	second (time)
min	minute = 60 s
h	hour = 60 min
a	annum (year) = 8760 h
m	metre
m^2	square metre
m^3	cubic metre

Units	Meaning
km	kilometre
km^2	square kilometre
ha	hectare
^oC	degrees Centigrade
toe	tonnes of oil equivalent (= 41.868 GJ) IEA Standard
tce	tonnes of coal equivalent (= 23.446 GJ) IEA Standard

Currency	Meaning
KSh	Kenya Shillings
kKSh	Thousands of Kenya Shillings = 10^3 KSh
MKSh	Millions of Kenya Shillings = 10^6 KSh
$	United States Dollars
$A	Australian Dollars

Conversion Factors - Imperial to SI (metric)

	Imperial		Conversion
Quantity	Meaning	Units	Imperial to SI
Area	square foot	ft^2	0.092 903 m^2
	square yard	yd^2	0.836 127 m^2
Density	pounds per cu.ft.	lb/ft^3	16.018 5 $kg.m^{-3}$
Energy	British Thermal Unit	Btu	1.055 06 kJ
Flow	gallon per minute	gpm	0.075 768 $L.s^{-1}$
Heat value	Btu per cu.ft.	Btu/ft^3	37.258 9 $kJ.m^{-3}$
	Btu per pound	Btu/h	2326 $J.kg^{-1}$
Heat flow	Btu per hour	Btu/h	0.293 071 W

Conversion Factors - Imperial to SI (metric) (Cont'd)

Length	inch	in	0.0254 m
	foot	ft	0.304 8m
	yard	yd	0.914 4m
Mass	pound	lb	0.453 592 37 kg
	ton	T	1016.05 kg
Mass flow	pounds per hour	lb/h	0.000 126 $kg.s^{-1}$
Pressure	bar	bar	100 kPa
	pounds per sq. in.	lb/sq.in	6894.76 Pa
	inch of water	"wg	248.642 Pa
	inch of mercury	"Hg	3386.39 Pa
Power	horsepower	hp	745.7 W
Refrigeration capacity	ton	T	3.516 85 kW
Temperature	degree Fahrenheit	^{o}F	[273 + 0.556 (F-32)]^{o}K
Volume	cubic foot	ft^3	0.028 316 $8m^3$
	cubic yard	yd^3	0.764 555 m^3
	gallon	gal	4.546 litres
Velocity	foot per sec	ft/s	0.304 8 $m.s^{-1}$
	miles per hour	mph	1.609 34 $km.h^{-1}$

Energy Conversion Factors

Energy Source	Gross Specific Energy	Density kg/m^3	Tonnes of Oil Equivalent toe
Coal	26.8	1130	0.56
Charcoal	29.0	NA	0.69
*Wood 20% mcwb	16.3	496 (solid)	0.39
30% "	14.2	527 (solid)	0.34
40% "	12.2	565 (solid)	0.29
50% "	10.2	609 (solid)	0.24
60% "	8.1	661 (solid)	0.19
70% "	6.1	722 (solid)	0.15
Animal waste	8.6	NA	0.20
Bagasse (30% moisture)	12.6	115	0.30
Coffee husk	15.1	NA	0.36
Cotton seed husk	15.1	NA	0.36
Flax	15.3	NA	0.37
Jute sticks	12.6	NA	0.30
Leather shavings	15.4	NA	0.37
Maize cobs	15.0	NA	0.36
Municipal waste	8.7	NA	0.21
Nut shells	19.7	NA	0.47
Palm shell	18.8	NA	0.45
Palm shell & fibre	11.3	NA	0.27
Palm stalk	22.1	NA	0.53
Rice husks	12.6	NA	0.30
Spent tan bark	5.7	NA	0.14
Straw	11.1	NA	0.27
Sunflower husk	17.5	NA	0.42
Liquified Petroleum Gas (LPG) - Propane	50.0	508	1.08
Petrol (GLN)	46.5	726	1.05
Kerosene/jet fuel (DPK)	46.0	820	1.03
Gas oil (GAO)	45.7	827	1.02
Industrial diesel (IDO)	45.5	840	1.01
Fuel oil (RFO)	42.9	939	0.98
Electricity 1 MWh	(3.6 GJ)	NA	0.086

* Note : 1 cubic metre stacked wood = 0.6 cubic metre solid volume.

APPENDIX B

TEA INDUSTRY ENERGY USAGE DATABASE

APPENDIX B - TEA INDUSTRY ENERGY USAGE DATABASE

1. DESIGN OF DATABASE

In order to establish the pattern of energy consumption in the KTDA and to develop a predict energy use model, for Kenyan Tea Industry Energy Usage Database was prepared and is reproduced in this Appendix.

The Database compiles available FY 1985 data on energy use in the Kenya Tea Development Authority. Data for the audited tea factories has been obtained from the 19 Energy Audit Reports which have been bound and issued individually. Data for non audited factories has been obtained from the returned Energy Survey Questionnaires.

The Database was prepared employing the internationally known Lotus 1-2-3 spreadsheet programme, using the project microcomputer.

Software for the Database has been handed over to the MOERD for this purpose and it is recommended that such surveys continue to be completed annually by the MOERD. Some work would be needed on survey form design, but this again is simply a matter of progressive development.

In addition, the Database was extended using the Lotus capabilities to include energy usage projections up to the year 1995, the time frame of the present study. The overall objective was to determine not only the existing pattern of energy consumption in the KTDA factories, but also the likely outcome of an effective energy conservation programme, based on the results obtained from the 19 energy audits carried out and extrapolating them intelligently to cover all KTDA factories. Notes are included below to indicate the construction and specific purpose of each of the individual spreadsheet files which from the Database.

As noted in this Appendix, the Database provides information on:

- Factory Name, Province, Plant Installed, Production and Energy Source, and
- Energy Source - Type, Cost, Actual Consumption, Target Consumption.

Energy demand projections for each energy source were based on the 1985 Energy Survey Questionnaires. With this basis, the enrgy conservation potential can be factored in as appropriate for each individual factory. In addition, the conservation potential in industry can be expressed, for simplicity, in terms of achievable targets for energy use per unit of production, typically GJ/tonne, and index usually referred to as energy intensity. The targets are defined at two levels, thus:

Target 1 (Short Term)	Energy savings target, achievable, based on conservation measures which could be taken almost immediately with minimum engineering input and, in general, minimum capital investment. Typically, such measures would show a simple payback of under one year and would include basic housekeeping and correct operating and maintenance practices.
Target 2 (Long Term)	Energy savings target, achievable, based on conservation measures which could be taken, with appropriate planning and engineering input and the expectation of capital investment in new or improved plant or processes or a more economic energy course, and which would give an acceptable economic and financial rate of return, (i.e. greater than 15% real).

Targets were set in accordance with:

- the results of the audit programme as presented in the 19 Energy Audit Reports;
- internationally accepted standards for the tea industry (suitably modified for Kenyan conditions), and
- the Consultants' experience in similar work.

In this way, the Database and target settings can be used to establish existing and future energy consumptions and to compute energy conservation and cost saving potential for the KTDA factories for a wide range of scenarios.

2. CONSTRUCTION OF THE DATABASE

The Kenya Tea Industry Energy Usage Database comprises a number of data files, each of which serves a distinct purpose. The notes in the sections following describe the content and purpose of each of the following files:

File (KTDA)	File Title
2	Energy Consumption by Energy Source - 1985 to 1995
3	Annual Energy Consumption by Factory by Energy Source - FY 1985
4	Energy Intensity by Factory by Energy Source - FY 1985
5	Energy Intensity: Current and Future Factory Performance

6 Energy Costs: Current and Future Factory Performance

KTDA 2 - Energy Consumption by Energy Source - FY 1985

This file aggregates energy consumption for FY 1985 for all KTDA factories. It sets out KTDA energy consumption by energy source, giving forecast consumption predictions for 1990 and 1995. The growth rate applied to 1985 consumption is taken as 3% for existing factories.

Overlying this basic growth rate, provision is made for two energy management factors to estimate the effects of the application of energy management initiatives as reported in each individual Energy Audit Report. The rate of energy performance improvement believed achievable by KTDA factories is a specific energy (GJ/t) reduction of 3% p.a. overall for 5 years, i.e. from FY 1986 - FY 1990 inclusive, as the essentially Target 1 potential is realised. A reduction of 2% p.a. is then allowed for the five years FY 1991 - FY 1995 as the residual Target 1 and new Target 2 initiates are taken up. Should experience show that these figures are either too ambitious or too conservative, then the factors can readily be changed to create a new and more realistic prediction on the Database.

KTDA 3 - Annual Energy Consumption by Factory by Energy Source - FY 1985

This file includes all data available to the Consultants on FY 1985 energy consumption for KTDA factories as obtained from the Energy Survey Questionnaires returned by all factories. All other files extract their data from this file.

KTDA 4 - Energy Intensity by Factory by Energy Source - FY 1985

This file includes factory made tea production figures for FY 1985 and hence derived energy intensity, firstly for each energy source, then overall for the factory. This enables immediate comparison between factories having the same plant arrangement, for example in electricity usage.

KTDA 5 - Energy Intensity - Current and Future Factory Performance

This file, which uses output data from the previous files, sets out the actual FY 1985 energy intensity, but now includes the target energy intensities (Target 1 and Target 2) arising from the Consultants' work as given in the Energy Audit Reports. From these figures, the target energy reductions in each factory are obtained. For the audited factories the target reductions are based upon the observations of the Audit Teams as reported. For the non-audited factories, the Consultants have taken the assumption that comparable target performances for comparable plant outputs, configurations and fuel type can be achieved.

KTDA 6 - Energy Costs - Current and Future Factory Performance

This file is based upon the input data for file KTDA 5, converted to a cost base. For simplicity of file manipulation, average cost figures based on field advised prices for each energy source were adopted.

These averages were:

IDO	6.50 KSh/L	170 KSh/GJ
RFO	2.90 KSh/L	72 KSh/GJ
Woodfuel	300 KSh/t	21 KSh/GJ
Electricity	0.72 KSh/kWh	200 KSh/GJ

For the non-audited factories, Target (T1) energy cost savings were based on the average cost (see above) of the main fuel source and the energy intensity reductions in File KTDA 5. Target 2 (T2) savings were based on the assumptions of File KTDA 5. This file aggregates the anticipated financial savings for all KTDA factories as a consequence of the Energy Management Programme.

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KENYA : ENERGY EFFICIENCY IN THE TEA INDUSTRY DATE : 22-Jul-86

ENERGY CONSUMPTION (TERAJOULES) BY ENERGY SOURCE 1985 TO 1995 FILE : KTDA2

ENERGY SOURCE	1985 TJ	1990 TJ	1995 TJ	GROWTH RATE (% PA)	ENERGY MANAGEMENT 1986-90	1991-95
IDO	24.8	24.8	26.1	3.0	-3.0	-2.0
RFO	1057.0	1057.0	1110.9	3.0	-3.0	-2.0
ELECTRICITY	125.0	125.0	131.4	3.0	-3.0	-2.0
WOOD	234.1	234.1	246.1	3.0	-3.0	-2.0
TOTAL	1440.9	1440.9	1514.4			

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KENYA : ENERGY EFFICIENCY IN THE TEA INDUSTRY DATE: 22-Jul-86

ENERGY CONSUMPTION BY FACTORY BY ENERGY SOURCE - FY 1985 FILE: KTDA3

KTDA FACTORY	DISTRICT	PLANT	AUDIT Y/N	IDO TJ/a	RFO TJ/a	ELECT TJ/a	WOOD TJ/a	TOTAL TJ/a
MUNGANIA	EMBU	OA	Y		25.3	3.5		28.7
RUKURIRI	EMBU	OA	N	11.9	30.2	S/G		42.2
KAPKOROS	KERICHO	OA	N		41.4	N/S		41.4
KAPSET	KERICHO	OA	Y	0.1	53.7	4.6		58.4
LITEIN	KERICHO	OA	Y	0.1	32.3	3.8		36.2
MOGOGOSIEK	KERICHO	OA	N		32.0	4.6		36.6
TEGAT	KERICHO	OA	Y	0.1	44.8	3.8		48.6
KAGWE	KIAMBU	OA	N	0.1	20.2	3.2		23.4
KAMBAA	KIAMBU	OA	Y	0.1	20.8	2.0		22.8
MATAARA	KIAMBU	OS	Y	0.1	43.7	7.2		51.0
THETA	KIAMBU	OA	N	0.1	22.9	4.0		26.9
KANGAITA	KIRINYAGA	WS	N		6.4	3.5	49.6	59.5
KIMUNYE *	KIRINYAGA	OA	Y	0.2	20.2	4.0		24.4
THUMAITA	KIRINYAGA	WS	Y	0.1	4.2	2.4	30.9	37.6
KEBIRIGO	KISII	OA	N	0.4	40.9	3.0		44.3
KIAMOKAMA	KISII	OS	Y	0.1	29.8	2.8		32.7
NYAMACHE *	KISII	OA	N		24.8	2.8		27.6
NYANKOBA	KISII	OA	N	0.3	29.3	2.1		31.7
NYANSIONGO	KISII	OA	Y	0.1	19.8	3.6		23.5
OGEMBO	KISII	OA	N		17.1	4.3		21.4
SANGANYI	KISII	OA	N		27.5	3.8		31.3
TOMBE	KISII	OA	N		24.2	6.1		30.2
GITHONGO	MERU	WS	Y			2.2	56.6	58.9
IMENTI	MERU	WS	N/S		33.8	3.8		37.5
KIEGOI	MERU	OA	N	9.5	25.9	S/G		35.4
KINORO	MERU	OA	Y	0.1	20.6	3.4		24.1
GATUNGURU *	MURANG'A	OA	N	0.1	37.2	5.1		42.4
GITHAMBO *	MURANG'A	OA	N	0.2	33.9	3.5		37.6
IKUMBI	MURANG'A	OS	Y	0.2	48.5	3.1		51.7
KANYENYAINI *	MURANG'A	OA	Y	0.2	31.0	4.4		35.6
MAKOMBOKI *	MURANG'A	OA	N	0.2	31.5	N/S		31.6
NJUNU *	MURANG'A	OA	N	0.1	31.4	1.3		32.8
CHEBUT	NANDI	WS	Y	0.1		3.0	40.7	43.7
CHINGA	NYERI	OS	Y	0.2	49.6	3.9		53.7
GATHUTHI	NYERI	WS	Y	0.1		2.2	28.9	31.3
GITUGI	NYERI	OA	N		25.5	4.0		29.5
IRIAINI	NYERI	OA	Y	0.1	41.6	4.1		45.8
NDIMA	NYERI	OA	Y	0.2	35.1	3.7		39.0
RAGATI	NYERI	WS	N			2.4	27.4	29.8
TOTALS				24.79	1057.03	124.98	234.11	1440.9

LEGEND :
Y = Yes O = Oil Firing S = Steam Heater N/S = Data not supplied - energy consumptions are derived from estimated energy intensities
N = No W = Wood Firing A = Air Heater
S/G = Self Generated
* = Dual fuel boilers (1986)

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KENYA : ENERGY EFFICIENCY IN THE TEA INDUSTRY

DATE: 23-Jul-86

ENERGY INTENSITY BY FACTORY BY ENERGY SOURCE - FY 1985

FILE: KTDA4

KTDA FACTORY	DISTRICT	AUDIT Y/N	OUTPUT tMT	IDO GJ/t	RFO GJ/t	ELECT GJ/t	WOOD GJ/t	TOTAL GJ/t
MUNGANIA	EMBU	Y	1685		15.0	2.1		17.1
RUKURIRI	EMBU	N	1421	8.40	21.3	S/G		29.7
KAPKOROS	KERICHO	N	1864		22.2	N/S		22.2
KAPSET	KERICHO	Y	1941	0.03	27.7	2.4		30.1
LITEIN	KERICHO	Y	1909	0.04	16.9	2.0		19.0
MOGOGOSIEK	KERICHO	N	1860		17.2	2.5		19.7
TEGAT	KERICHO	Y	1990	0.04	22.5	1.9		24.4
KAGWE	KIAMBU	N	860	0.09	23.4	3.7		27.2
KAMBAA	KIAMBU	Y	1226	0.06	17.0	1.6		18.6
MATAARA	KIAMBU	Y	1600	0.06	27.3	4.5		31.9
THETA	KIAMBU	N	1376	0.07	16.6	2.9		19.6
KANGAITA	KIRINYAGA	N	2089		3.1	1.7	23.8	28.5
KIMUNYE	KIRINYAGA	Y	1574	0.15	12.8	2.5		15.5
THUMAITA	KIRINYAGA	Y	1600	0.08	2.6	1.5	19.3	23.5
KEBIRIGO	KISII	N	1566	0.24	26.1	1.9		28.3
KIAMOKAMA	KISII	Y	1507	0.05	19.8	1.9		21.7
NYAMACHE	KISII	N	1165		21.3	2.4		23.7
NYANKOBA	KISII	N	1141	0.24	25.7	1.8		27.8
NYANSIONGO	KISII	Y	1623	0.04	12.2	2.2		14.5
OGEMBO	KISII	N	1267		13.5	3.4		16.9
SANGANYI	KISII	N	1236		22.2	3.1		25.3
TOMBE	KISII	N	1800		13.4	3.4		16.8
GITHONGO	MERU	Y	1142			1.9	49.6	51.5
IMENTI	MERU	N/S	1500		22.5	2.5		25.0
KIEGOI	MERU	N	1391	6.86	18.6	S/G		25.5
KINORO	MERU	Y	1212	0.06	17.0	2.8		19.9
GATUNGURU	MURANG'A	N	2109	0.05	17.6	2.4		20.1
GITHAMBO	MURANG'A	N	1514	0.11	22.4	2.3		24.8
IKUMBI	MURANG'A	Y	2410	0.08	20.1	1.3		21.5
KANYENYAINI	MURANG'A	Y	2101	0.09	14.8	2.1		16.9
MAKOMBOKI	MURANG'A	N	2340	0.07	13.5	N/S		13.5
NJUNU	MURANG'A	N	1689	0.05	18.6	0.7		19.4
CHEBUT	NANDI	Y	1740	0.05		1.7	23.4	25.1
CHINGA	NYERI	Y	1798	0.10	27.6	2.2		29.9
GATHUTHI	NYERI	Y	1271	0.11		1.8	22.7	24.6
GITUGI	NYERI	N	1247		20.4	3.2		23.6
IRIAINI	NYERI	Y	1571	0.07	26.5	2.6		29.1
NDIMA	NYERI	Y	2320	0.07	15.1	1.6		16.8
RAGATI	NYERI	N	1415			1.7	19.4	21.1
TOTAL / WEIGHTED AVERAGE			63072	---	---	---	---	22.8

LEGEND : Y = Yes   N/S = Data Not Supplied - Energy intensities are estimates only
N = No   S/G = Self Generated

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KENYA : ENERGY EFFICIENCY IN THE TEA INDUSTRY

DATE: 23-Jul-86

ENERGY INTENSITY : CURRENT AND FUTURE FACTORY PERFORMANCE

FILE: KTDA5

KTDA FACTORY	DISTRICT	ENERGY USAGE TJ	OUTPUT MADE TEA tMT	ENERGY INTENSITY 1985 GJ/tMT	ENERGY INTENSITY TARGET 1 GJ/tMT	ENERGY INTENSITY TARGET 2 GJ/tMT	ENERGY REDUCTION TARGET 1 GJ/tMT	ENERGY REDUCTION TARGET 1 %	ENERGY REDUCTION TARGET 2 GJ/tMT	ENERGY REDUCTION TARGET 2 %
MUNGANIA	EMBU	28.7	1685	17.1	15.85	15.85	1.21	7.1	0.00	0.0
RUKURIRI	EMBU	42.2	1421	29.7	23.70	23.70	5.97	20.1	0.00	0.0
KAPKOROS	KERICHO	41.4	1864	22.2	18.20	18.20	4.00	18.0	0.00	0.0
KAPSET	KERICHO	58.4	1941	30.1	20.24	20.24	9.83	32.7	0.00	0.0
LITEIN	KERICHO	36.2	1909	19.0	14.63	14.63	4.34	22.9	0.00	0.0
MOGOGOSIEK	KERICHO	36.6	1860	19.7	17.70	17.70	1.97	10.0	0.00	0.0
TEGAT	KERICHO	48.6	1990	24.4	18.04	16.46	6.40	26.2	1.58	8.8
KAGWE	KIAMBU	23.4	860	27.2	21.20	21.20	6.05	22.2	0.00	0.0
KAMBAA	KIAMBU	22.8	1226	18.6	18.17	18.17	0.44	2.4	0.00	0.0
MATAARA	KIAMBU	51.0	1600	31.9	27.56	27.56	4.34	13.6	0.00	0.0
THETA	KIAMBU	26.9	1376	19.6	17.59	17.59	2.00	10.2	0.00	0.0
KANGAITA	KIRINYAGA	59.5	2089	28.5	22.50	19.00	6.00	21.0	3.50	15.6
KIMUNYE	KIRINYAGA	24.4	1574	15.5	13.88	13.88	1.61	10.4	0.00	0.0
THUMAITA	KIRINYAGA	37.6	1600	23.5	21.95	20.00	1.56	6.6	1.95	8.9
KEBIRIGO	KISII	44.3	1566	28.3	22.30	22.30	5.99	21.2	0.00	0.0
KIAMOKAMA	KISII	32.7	1507	21.7	15.55	15.55	6.17	28.4	0.00	0.0
NYAMACHE	KISII	27.6	1165	23.7	19.70	19.70	4.00	16.9	0.00	0.0
NYANKOBA	KISII	31.7	1141	27.8	21.80	21.80	5.97	21.5	0.00	0.0
NYANSIONGO	KISII	23.5	1623	14.5	13.00	13.00	1.47	10.2	0.00	0.0
OGEMBO	KISII	21.4	1267	16.9	14.90	14.90	1.98	11.7	0.00	0.0
SANGANYI	KISII	31.3	1236	25.3	21.30	21.30	4.00	15.8	0.00	0.0
TOMBE	KISII	30.2	1800	16.8	14.80	14.80	2.00	11.9	0.00	0.0
GITHONGO	MERU	58.9	1142	51.5	29.87	19.23	21.67	42.0	10.64	35.6
IMENTI	MERU	37.5	1500	25.0	21.00	19.00	4.00	16.0	2.00	9.5
KIEGOI	MERU	35.4	1391	25.5	21.50	21.50	3.96	15.6	0.00	0.0
KINORO	MERU	24.1	1212	19.9	15.81	15.81	4.11	20.6	0.00	0.0
GATUNGURU	MURANG'A	42.4	2109	20.1	18.10	18.10	2.00	10.0	0.00	0.0
GITHAMBO	MURANG'A	37.6	1514	24.8	20.80	20.80	4.01	16.2	0.00	0.0
IKUMBI	MURANG'A	51.7	2410	21.5	18.15	18.15	3.32	15.4	0.00	0.0
KANYENYAINI	MURANG'A	35.6	2101	16.9	16.65	16.65	0.30	1.8	0.00	0.0
MAKOMBOKI	MURANG'A	31.6	2340	13.5	13.50	13.50	0.02	0.2	0.00	0.0
NJUNU	MURANG'A	32.8	1689	19.4	17.40	17.40	2.01	10.3	0.00	0.0
CHEBUT	NANDI	43.7	1740	25.1	21.81	19.00	3.31	13.2	2.81	12.9
CHINGA	NYERI	53.7	1798	29.9	25.67	25.67	4.19	14.0	0.00	0.0
GATHUTHI	NYERI	31.3	1271	24.6	21.13	16.11	3.48	14.1	5.02	23.8
GITUGI	NYERI	29.5	1247	23.6	19.60	19.60	4.04	17.1	0.00	0.0
IRIAINI	NYERI	45.8	1571	29.1	20.14	20.14	9.01	30.9	0.00	0.0
NDIMA	NYERI	39.0	2320	16.8	14.02	14.02	2.78	16.5	0.00	0.0
RAGATI	NYERI	29.8	1415	21.1	18.00	15.00	3.06	14.5	3.00	16.7
TOTAL / WEIGHTED AVERAGE		1440.9	63072	22.8	18.9	18.2	4.0	17.3	0.7	3.7

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KENYA : ENERGY EFFICIENCY IN THE TEA INDUSTRY — DATE: 23-Jul-86

ENERGY COSTS : CURRENT AND FUTURE FACTORY PERFORMANCE — FILE: KTDA6

KTDA FACTORY	DISTRICT	ENERGY USAGE TJ	OUTPUT MADE TEA t MT	CURRENT kKSH	CURRENT KSH/k	ENERGY COST TARGET 1 KSH/kgMT	ENERGY COST TARG KSH/	ENERGY COST SAVINGS TARGET 1 KSH/kgMT	TARGET 1 %	TARGET 2 KSH/kgMT	TARGET 2 %
MUNGANIA	EMBU	28.7	1685	2514	1.49	1.39	1.05	0.10	6.8	0.34	24.5
RUKURIRI	EMBU	42.2	1421	4206	2.96	2.35	1.85	0.60	20.4	0.50	21.2
KAPKOROS	KERICHO	41.4	1864	2980	1.60	1.29	0.79	0.31	19.3	0.50	38.8
KAPSET	KERICHO	58.4	1941	4796	2.47	1.74	1.46	0.73	29.6	0.28	16.0
LITEIN	KERICHO	36.2	1909	3101	1.62	1.28	1.04	0.35	21.3	0.24	18.4
MOGOGOSIEK	KERICHO	36.6	1860	3220	1.73	1.58	1.08	0.15	8.8	0.50	31.7
TEGAT	KERICHO	48.6	1990	3990	2.01	1.57	0.93	0.43	21.6	0.64	41.0
KAGWE	KIAMBU	23.4	860	2107	2.45	1.44	0.94	1.01	41.3	0.50	34.8
KAMBAA	KIAMBU	22.8	1226	1901	1.55	1.50	1.36	0.05	3.0	0.15	9.7
MATAARA	KIAMBU	51.0	1600	4605	2.88	2.63	1.70	0.24	8.4	0.93	35.4
THETA	KIAMBU	26.9	1376	2457	1.79	1.58	1.06	0.21	11.7	0.52	33.0
KANGAITA	KIRINYAGA	59.5	2089	2199	1.05	0.93	0.73	0.12	11.5	0.20	21.5
KIMUNYE	KIRINYAGA	24.4	1574	2292	1.46	1.33	1.22	0.13	8.6	0.11	8.0
THUMAITA	KIRINYAGA	37.6	1600	1454	0.91	0.83	0.64	0.08	8.7	0.19	22.3
KEBIRIGO	KISII	44.3	1566	3608	2.30	1.75	1.25	0.55	23.9	0.50	28.5
KIAMOKAMA	KISII	32.7	1507	2728	1.81	1.29	0.84	0.52	28.6	0.45	35.0
NYAMACHE	KISII	27.6	1165	2348	2.01	1.52	1.02	0.49	24.5	0.50	32.9
NYANKOBA	KISII	31.7	1141	2578	2.26	1.51	1.01	0.75	33.4	0.50	33.2
NYANSIONGO	KISII	23.5	1623	2158	1.33	1.18	0.98	0.15	11.5	0.19	16.4
OGEMBO	KISII	21.4	1267	2088	1.65	1.42	0.92	0.22	13.6	0.50	35.1
SANGANYI	KISII	31.3	1236	2738	2.22	1.75	1.25	0.47	21.1	0.50	28.6
TOMBE	KISII	30.2	1800	2952	1.64	1.48	1.02	0.16	9.8	0.46	31.1
GITHONGO	MERU	58.9	1142	1631	1.43	1.17	0.96	0.26	17.9	0.21	18.1
IMENTI	MERU	37.5	1500	3000	2.00	1.89	1.69	0.11	5.6	0.20	10.6
KIEGOI	MERU	35.4	1391	3485	2.51	2.10	1.60	0.41	16.4	0.50	23.9
KINORO	MERU	24.1	1212	2186	1.80	1.48	1.26	0.33	18.1	0.22	14.8
GATUNGURU	MURANG'A	42.4	2109	3721	1.76	1.63	1.13	0.14	7.7	0.50	30.7
GITHAMBO	MURANG'A	37.6	1514	3175	2.10	1.72	1.22	0.38	18.2	0.50	29.1
IKUMBI	MURANG'A	51.7	2410	4134	1.72	1.45	0.94	0.27	15.6	0.51	35.0
KANYENYAINI	MURANG'A	35.6	2101	3142	1.50	1.45	0.74	0.05	3.2	0.70	48.6
MAKOMBOKI	MURANG'A	31.6	2340	2294	0.98	0.98	0.48	.00	0.1	0.50	51.1
NJUNU	MURANG'A	32.8	1689	2529	1.50	1.33	0.83	0.17	11.4	0.50	37.7
CHEBUT	NANDI	43.7	1740	1459	0.84	0.76	0.61	0.08	9.8	0.15	19.3
CHINGA	NYERI	53.7	1798	4387	2.44	2.10	1.07	0.34	13.8	1.03	49.0
GATHUTHI	NYERI	31.3	1271	1078	0.85	0.75	0.69	0.10	11.5	0.07	8.7
GITUGI	NYERI	29.5	1247	2633	2.11	1.65	1.15	0.47	22.1	0.50	30.4
IRIAINI	NYERI	45.8	1571	3834	2.44	1.72	1.24	0.72	29.5	0.48	27.8
NDIMA	NYERI	39.0	2320	3290	1.42	1.20	1.01	0.22	15.6	0.18	15.4
RAGATI	NYERI	29.8	1415	1055	0.75	0.65	0.65	0.09	12.2	.00	0.7
TOTAL / WEIGHTED AVERAGE		1440.9	63072	110053	1.74	1.46	1.04	0.29	16.4	0.41	28.4

APPENDIX C

BIOMASS AS AN ENERGY SOURCE FOR THE TEA INDUSTRY

Prepared by:

Forestry Technical Services Pty Ltd

BIOMASS AS AN ENERGY SOURCE FOR THE TEA INDUSTRY

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

1.1 Woody biomass supplies 95% all biomass energy in Kenya and 71% (as of 1980) of the total energy demand of all sectors. The dominant fuelwood sector is domestic.

1.2 About 47% of the national fuelwood supply comes from farm trees and bushes, 28% from forest trees and 25% from rangelands.

1.3 There is a fuelwood deficit in the high population density areas of high agricultural potential, notably in Western Kenya where tea production occurs and where a number of KTDA's factories are located.

1.4 The KTDA acts as managing agent for 39 tea factories which produced nearly 64 000 tonnes of made tea in 1984/85 from about 55 000 ha of tea grown by 150 000 smallholders. This represents around 45% of Kenya's total tea production. A separate company owns each factory with smallholders being the main shareholders. The KTDA smallholder scheme which has been operating for some 20 years is regarded as being among the most successful in the world.

1.5 Subject to availability of supply, KTDA policy is progressively to convert a number of factories to fuelwood for the drying process, displacing imported oil. Six factories presently use wood exclusively and one predominantly.

1.6 If all factories were hypothetically to convert to fuelwood, fuelwood usage at 1985 production levels would be about 100 000 tonnes/y assuming use of wood of 527 kg/cu.m density at 30% mcwb at 14.2 GJ/t gross specific energy (GSE). Current energy intensities of around 1.5 t of wood per tonne of made tea (22-23 GJ/t) could however be reduced to avoid 1.0 t of wood (14-15 GJ/t) with improved combustion processes with a corresponding drop in the potential fuelwood demand to about 65 000 t/y.

1.7 In 1979 the Forest Department is understood to have promised adequate supplies of fuelwood for 22 KTDA factories. By 1985 fuelwood supply to the present 7 fuelwood operated factories had become uncertain, and it is believed no confirmation has been received since then from the Forest Department as to the likelihood of meeting the 1979 supply commitment. KTDA management sees the Forest Department as its primary source of supply, and is thus concerned to see that supply commitments are honoured.

1.8 The 1985 market prices of fuelwood energy were estimated from visits to four factories to be about 15.1 KSh/GJ from native forest species, to about 20.5 KSh/GJ using plantation Eucalyptus saligna. This compared with the 1985 recorded cost of energy from fuel oil at 77.6 KSh/GJ and 82.8 KSh/GJ at factories east and west of the Rift Valley respectively. However it is required that the economic price for fuelwood is higher than the market price while by 1986 the reverse was true for fuel oil.

1.9 A series of five, later six, options were examined for enhancement of fuelwood supply to KTDA within the limited time constraints of the brief.

These were:

- Forest Department lands.
- Unused roadside areas and other public lands available for fuelwood.
- Future surplus in private tea estate fuelwood plantations with improved factory energy efficiency.
- Smallholder woodlot potential.
- Crop residues.

The Consultant was subsequently advised that sawdust was available as a potential biomass resource in Districts which have substantial sawmilling operation. Sawdust is most appropriate fuel, but requires appropriate combustion equipment of a type not now installed.

1.10 Combining Forest Department, public lands and smallholder models, the cost of fuelwood production (royalty) is 29%, harvesting 25% and transport 46% at not more than 10km distance from factory, making delivered cost very sensitive to transport cost.

1.11 The first and most attractive fuelwood supply priority is from Forest Department lands. If existing fuelwood plantations were fully productive they could produce two thirds (66%) of all KTDA factory needs if all yield was sold to KTDA. The Consultant has assumed 50% allocation but confirmation is needed. Yield status of plantations should also be confirmed by inventory. Energy cost is about 24 KSh/GJ at 10km distance.

1.12 Underutilised public lands, if available, have the potential to provide KTDA with say one quarter (25%) of total estimated factory fuelwood needs, possibly at say 35 KSh/GJ (nearly twice the cost of other options if fencing is used) but still half that of oil energy at 1985 prices. Innovative community involvement could reduce costs. However, there is some doubt as to community acceptability of this option which is used successfuly in some developing countries.

1.13 Private tea estate factories have the potential to reduce fuelwood use by about one third by increasing energy efficiency by improved combustion techniques. A surplus of fuelwood is however unlikely to occur from this source as tea would probably be planted on the land freed by fuelwood as a more profitable crop, unless it were decreed otherwise.

1.14 From theoretical considerations and from recent land use survey data of Beijer Institute the smallholder model appears capable of producing more fuelwood than the needs of all the KTDA factories given market and price guarantees. Energy cost of about 23 KSh/GJ are estimated, being comparable with the Forest Department model. Again some reservations are held locally concerning community acceptability of this option and careful testing would be needed. Furthermore market prices would need to increase to make this option attractive to growers.

1.15 Some 6 000 tonnes/y of rice husks are estimated to be available, and could be utilised by KTDA with appropriate furnace modifications at a delivered cost of about 15 KSh/GJ, the apparent cost of loading and transport. The availability and cost should be confirmed.

1.16 Some 33 000 tonnes/y of sawdust were advised to the Consultants as being produced by all sawmills in Kenya (Refer Appendix E). Sawdust is a premium fuel and could also be delivered at about 15 KSh/GJ. The availability and cost should also be confirmed to those few factories located such that a supply might be appropriate.

1.17 The Forest Department apparently has a conifer pulpwood surplus which in quantity could be adequate for all KTDA factory needs, but probably at say 35 KSh/GJ delivered cost. The availability and cost should again be confirmed.

1.18 In summary, a fuelwood supply strategy for KTDA is suggested as:

Supply Source	Approx t/y	%(1)	Probability of Supply
Preferred Supply			
Forest Department			
- Hardwood	25 - 50 000	25 - 50	High
- Conifer pulpwood	to 140 000	to 100	Low - medium
Opportunity Supply (to be further evaluated)			
Rice husks	6 000	6	Low
Sawdust	33 000	30 - 40	Low - Medium
Non-Preferred Supply			
Public lands	10 - 25 000	10 - 25	High
Smallholder	50 -100 000	50 - 100	Medium - high

Note (1) Percent of estimated KTDA needs of 100 000 t/y fuelwood. If efficiency gains can lead to a reduced demand of 65 000 t/y, the percentages are increased accordingly. Furthermore it has been clearly stated by KTDA that by no means all factories, and particularly those in the fuelwood deficit areas of Western Kenya, are proposed for conversion from fuel oil.

1.19 A Pilot Biomass Demonstration Project is proposed, as discussed in Annexure C3, to confirm the biomass data base of the Forest Department and to carry out pilot scale fuelwood establishment trials. The estimated cost of the programme would be about $US 1.2 million, spread over say 3 years.

1.20 Eucalyptus species, especially E. saligna, and more recently E. grandis (for the Tea Zone), have been used to produce high wood and net energy yields as fuelwood. For the Coffee Zone Eucalyptus species from drier parts of Australia are suggested such as E. camaldulensis from North Queensland. Other species are discussed in Annexure C4. Species/ provenance trials should be initiated by KTDA in co-operation with overseas agencies, important among which are Australian Centre for International Agricultural Research (ACIAR) which has begun a tree species trial project with the Kenya Agricultural Research Institute.

2.0 INTRODUCTION AND TERMS OF REFERENCE

2.1 Introduction

The Kenya Tea Development Authority is a parastatal body established to manage the processing of tea from the smallholder sector. The smallholder scheme has been very successful, with 150 000 farmers who delivered some 287 000 t of green leaf in 1984/85 to 39 KTDA factories in Kenya's fertile highlands, producing 63 700 t of made tea. The area under tea is 56 000 ha with an average tea plot size of 0.38 ha per farm.

The private tea estates produced nearly 55% of Kenya's tea from around 24 000 ha with made tea yields averaging 2 800 kg/ha compared to about 900 kg/ha for the KTDA smallholder, with the latter producing very high tea quality.

32 KTDA factories are fuelled with furnace oil for drying and the remaining 7 factories operate on wood, with one of these using some oil in addition. KTDA's policy is to change all the oil using factories progressively to fuelwood as and when assured supplies become available, whether that be now or in the future. The Consultant's Brief reinforces this policy.

Fuelwood supplies to date have come almost exclusively from the Forest Department. The KTDA considers this as its logical source of supply. Naturally it has concern for the continuing security of that supply to its 7 wood using factories, as well for as its policy to convert the remaining factories to wood as soon as possible.

The KTDA sees the change from oil to cheaper (at 1985 prices) wood energy as a means of decreasing its costs and conferring higher monetary benefits to its growers. This has significance as each of the factories, in the form of a private company, are owned by some, but not all, green leaf growers and the KTDA acts as a managing agent for these 39 companies.

The national viewpoint, which may differ somewhat from that of the KTDA, is that the reduction of oil imports which use scarce foreign exchange is a desirable objective, and one which may in part be achieved by the substitution of indigenous fuels such as biomass, especially fuelwood. The absolute price of fuelwood derived energy may not therefore be the major issue in the national context, provided that it bears a reasonable relationship with oil energy to maintain made tea prices at attractive price levels for export markets.

2.2 Acknowledgements

The Forestry Consultant worked closely with other study team members in the engineering and economics disciplines as well as with the World Bank (ESMAP) Peri-Urban Fuelwood Study, and obtained significant assistance from staff of the KTDA, Forest Department and the Beijer Institute Kenya Wood Fuel Project. Several of the private estate tea companies such as Brooke Bond Kenya, African Highlands Produce Co Ltd, George Williamson Engineering and Kaisugu Ltd generously provided data, as also did BAT Kenya Ltd. The assistance of all the foregoing, additional to those recorded in Volume I of the Consultant's report, is gratefully acknowledged.

2.3 Terms of Reference

The Scope of Work for the forestry and biomass specialist was outlined as Task III of the World Bank's Activity Initiation Brief of July 1985, and is summarised as follows:-

- Establish whether existing forest resources of the Forest Department could meet the additional KTDA requirement without undue deforestation consequences, and at an economically acceptable cost. If natural forest reserves are not adequate, evaluate the technical feasibility and economic viability of fuelwood plantations.

- Determine the land areas required to provide fuelwood for the factories involved; examining land availability; land tenure; responsibility for establishment and management; legal and institutional arrangements; cost of establishment and production; financing; logistics and transport.

- Following this review, rank the available land in order of desired development using requirement of productive potential, social acceptance and least cost economic development as ranking criteria.

- Recommend appropriate species or provenance trials for a 4-5 year rotation cycle and establish a time schedule for plantation development.

- Complete financial and economic analyses of actions proposed including internal rate of return (IRR) and present value unit cost estimates.

- Recommend any manpower training and development needs for changed systems of production, and feed into Peri-Urban Fuelwood Plantation Programme action plan.

3.0 FUELWOOD SUPPLY AND DEMAND - OVERVIEW

3.1 Forest Resources

The nation's forest resources have been summarised by Openshaw (1982) as of 1980, by Province and forest type in Table 3.1 following:

TABLE 3.1 - FOREST AREA BY PROVINCE AND FOREST TYPE (ha)

Province/ Forest		Planted Forest Eucalyptus & wattle	Other species	Natural Forest(2) Commercial tree area	Non-comm	Bamboo & scrub	All Forest Total	Forest cover%
Nyanza	Exp	42	680	960	1 865	290	38 371)	0.3
	Pro	-	-	80	160	30	2 701)	
	NPk	-	-	-	-	-	-	-
Western	Exp	535	11 245	15 160	23 698	14 807	65 445)	8.3
	Pro	-	-	650	1 020	630	2 300)	
	NPk	-	-	-	-	-	-	
Central	Exp	2 675	24 952	47 340	55 558	79 675	210 206)	
	Pro	-	-	5 610	6 590	9 450	21 650)	20.8)
	NPk	-	-	10 910	12 810	18 380	42 100)	)
Nairobi	Exp	1 502	373	70	1 253	0	2 198)	)
	Pro	-	-	-	-	-	-)	31.1)
	NPk	-	-	10	20	-	30)	
Eastern	Exp	1 034	8 734	1 710	34 050	85 679	131 407)	
	Pro	-	-	140	2 760	6 960	9 860)	0.9
	NPk	-	-	10	110	280	400)	
Coast	Exp	243	2 205	40 260[3]	70 581[4]	5 556	118 845)	1.5
	Pro	-	-	570	1 290	100	1 960)	
	NPk	-	-	-	-	-	-	
Rift	Exp	14 889[1]	87 261	246 370	275 909	96 336	720 765)	
Valley	Pro	-	-	113 510	14 640	5 780	33 930)	4.6
	NPk	-	-	7 550	8 180	3 230	18 960)	
North East		0	0	0	0	0	0	0
TOTAL	Exp	20 920	135 456	351 870	461 914	282 543	1 252 703	
	Pro	-	-	20 560	26 460	22 950	69 970	
	NPk (5)	-	-	18 480	21 120	21 890	61 490	
GRAND TOTAL		20 920	135 456	390 910	509 486	327 383	1 384 163	2.4

Legend: Exp - Exploitable, Pro - Protection, NPk - National Park

Notes:

(1) Eucalyptus 9674 ha, wattle 5215.

(2) The commercial and non-commercial species are mixed, the areas of these two groups of species have been divided according to the volume of each group.

(3) The commercial area includes 21 677 ha of mangrove forest. Total mangrove area is 52 980 ha.

(4) The non-commercial area includes 31 303 ha of mangrove forest.

(5) The area of natural parks is much larger than 61 500 ha but this is the total forest area within the parks.

Table 3.1 includes all forest occurring in areas over 10 ha in size but excludes non-forest area within the forest such as grasslands, farms and areas of water. It must be noted that substantial amounts of biomass occur on smallholder farmlands, where they are unrecorded because they are under 10 ha in area. This biomass resource is dealt within Section C8.

Table 3.2 from FAO (1982) shows that nearly all (87%) of the land classed as forest estate is within gazetted forest. While this table cannot be directly compared to Table 3.1 due to different methods of vegetation classification, it does indicate that there is very little forest resource which is not under government control.

TABLE 3.2 - KENYA'S FOREST ESTATE

Type of Forests		Area (ha)
(i) Gazetted forests		
Natural high forests		919 157
Man-made forests		157 315
Bush		163 585
Bamboo		160 303
Grass		127 013
Mangrove		45 086
	Sub-total	1 572 459
(ii) Ungazetted forests		
Managed by the Forest Department		89 399
Total forest area under Forest Department management	Sub-total	1 661 858
(iii) Private forests on large farms		141 000
Kenya's Forest Estate	Total	1 802 858

Source: FAO (1982)

3.2 Fuelwood Supply and Demand

Much has been written on Kenya's apparent fuelwood supply problems. The official viewpoint is summarised in the National Energy Policy (Ministry Energy & Regional Development 1985). Evidence is presented that there will be a rapidly developing fuelwood shortage due to the assumed continued heavy reliance on wood as a fuel for domestic use. The 1983 estimate was that 62.8% of Kenya's gross energy demand was being met from fuelwood.

80% of all the fuelwood consumed in Kenya comes from private farms, woodlots or trust lands, while only 13% comes from government controlled forests and 7% from Trust Lands administered by County Councils (FAO 1982).

In considering fuel source options to enable the KTDA to move from oil to fuelwood for its tea factories, the macro supply/demand picture should be understood. There is a range of supply options open to the KTDA for obtaining up to 100 000 t/y of fuelwood estimated for its present 39 factories at current energy efficiency levels. However, the macro picture indicates this supply will face competing demands in the market place. Table 3.3 below shows a growing shortfall between supply and demand, estimated to reach 10 Mt/y by the year 1990, and 31 Mt/y by the year 2000. If allowed to proceed unchecked, or without planned replenishment, the effect on standing stock is quite clear.

TABLE 3.3 - NATIONAL WOOD FUEL RESOURCE SUPPLY/DEMAND RELATIONSHIP IN KENYA (MILLION TONNES)

Year	1982	1985	1990	1995	2000
Demand	20.0	24.5	30.3	38.6	47.1
Supply (total)	20.0	19.2	20.5	20.6	16.5
From Yield (1)	13.8	12.6	10.7	7.8	5.2
From Stock (2)	6.2	6.6	9.8	18.8	11.3
Supply shortfall	-	5.3	9.8	12.0	30.6
Standing stock	980.6	974.0	932.0	864.0	800.0

Source: Beijer Institute 1982 and Ministry of Energy and Regional Development 1985.

Notes:

(1) Yields: Net annual production. Only accessible yields service demand.
(2) Stocks: Net reduction in accessible standing stocks service demand when demand exceeds accessible yields.

Openshaw (1982) has constructed a biomass energy production and consumption model for Kenya which appears to form the basis for accepted status on fuelwood in the national energy policy (MOERD 1984 and Table 3.3). The underlying assumptions to Table 3.3 are as follows:-

1. Natural forest - Data was taken from a partial inventory carried out by a Canadian firm in 1963 -1967 and updated by the author following discussions in Kenya with various authorities. As a consequence stem volume was reduced by 17%, but a further 20% was added for branch volume.

2. Bamboo and scrub - Area was mapped but not inventoried. Biomass was estimated by assuming the proportion of bamboo land as constant at 48 cu.m /ha.

3. Forest plantation - Source of data assumed was taken from Forest Department records. However, there have been comments from various sources that more recent eucalyptus plantations may have been unsuccessful in some areas and require inventory to confirm yield potential.

4. Tree cover on high potential land - Field inventoried by Beijer Institute using samples selected from air photography in many cases. In fact all woody biomass was sampled. A little over 9% of land area had woody biomass canopy. This is consistent with recent Beijer Institute data which indicates 16% to 31% biomass for smallholder tea growing areas. See Table 8.1.

5. Consumption - Assumptions are not given in this paper.

The fuelwood Supply and Demand Model is shown in Table 3.4 on the following page.

TABLE 3.4 - ANNUAL PRODUCTION AND CONSUMPTION OF BIOMASS ENERGY IN WOOD EQUIVALENT TERMS

UNITS - 1000 TONNES WOOD EQUIVALENT

	NON-WOODY BIOMASS			WOODY BIOMASS						
				From High Potential Land					From	
Province	Agric	(1) Animal	Total	Forest	(2) Farm	Coffee	Urban	Total	Rangelands	Total
NYANZA	219	12	231	5	459	23	1	488	2	430
WESTERN	392	8	400	132	235	4	1	372	0	372
CENTRAL	50	6	56	496	561	144	2	1 173	7	1 180
NAIROBI	1	0	1	33	25	6	1	65	0	65
EASTERN	67	26	93	250	1 253	79	1	1 583	4 476	6 059
COAST	120	4	124	118	358	0	1	477	2 434	2 911
RIFT VALLEY	66	46	112	1 429	1 043	52	3	2 527	4 432	8 959
NORTH EAST	1	6	7	0	0	0	0	0	4 749	4 749
KENYA Sustainable Production	916	108	1 024	2 463	3 934	278	10	6 685	16 100	22 785
KENYA: Estimated Consumption	794	94	888	5 195	8 297	278	10	13 780	4 980	18 760
Percentage	89	11	100	28	45	2	0	75	25	100
Surplus/deficit	-122	-14	-136	-2 732	-4 363	0	0(3)	-7 095	111 120	-4 025
Estimated capital of woody biomass				129 177	73 765	850	181	203 973	690 000	393 973
wood for charcoal				1 750	875	-	-	2 625	3 200	55 825
wood for firewood				3 445	7 422	278	10	11 155	1 780	12 935

(1) Practically available.

(2) Includes rural built-up environment.

(3) It is assumed that the bulk of the urban wood energy comes either from the rangelands or the high potential lands and that no inroads are being made into urban tree capital.

Source: Openshaw 1982

Despite the limitations of the data underlying the Openshaw (1982) model, it has served as a valuable framework for examination of Kenya's fuelwood supply problems. The basis of the assumptions is being improved by continuing investigations by the Beijer Institute staff through the Kenya Fuelwood Development Project, and the World Bank Peri-Urban Fuelwood Project of the World Bank.

Openshaw's main conclusions (1982) outline the Kenyan fuelwood problems. They are summarised below to assist in a better understanding of the problems to be overcome in meeting the future fuelwood needs of the 39 KTDA tea factories, the primary aim of this study:

- Woody biomass supplies 95% of the total biomass energy demand, and 71% (in 1980 values) of the total national energy demand.

- The economic range for fuelwood supply is within walking distance for the rural consumer, or within economic transport distance of the urban/industrial consumer, typically 100 km for fuelwood and 200-300 km for charcoal.

- The rangelands are the wood surplus areas and could theoretically supply (as of 1980) nearly 90% of the fuelwood demand, but are out of economic transport range for the high deficit areas and are ecologically fragile.

- Farm trees and bushes supply about 47% of fuelwood energy demand, with 28% from forest trees and remaining 25% from rangelands.

- Openshaw's figures (Table 3.4) indicate an erosion of standing stock or woody biomass capital as of 1980. Regardless of the absolute validity of the figures, the model itself appears sound and is supported by the observations of the Forestry Consultant. The main conclusion is that there is a deficit in fuelwood in the high population density areas of high agricultural potential.

- The main recommendation of this study, therefore, is that the largest effort be in tree growing which should be in high potential agricultural areas where the greatest shortfall occurs. In some of these areas KTDA is already seeking future wood supplies.

4.0 PRESENT BIOMASS USE - KTDA FACTORIES

4.1 Green Leaf Supply and Production

Smallholder tea production in Kenya under the management of the KTDA involved some 150 000 farmers delivering, in 1983/84, over 210 000 tonnes of green leaf to 39 KTDA factories. The project, now some 20 years old, has been a major success in its field by world standards. It had World Bank support in the early 1970's.

Smallholder green leaf production has increased from about 160 000 tonnes in 1981/82 by 32% to just over 210 000 tonnes in 1983/84. Further increases can be expected by extending the area planted, and to some extent by increasing green leaf yields per hectare. As of 1983 some 81 500 ha of tea had been planted by all growers made up of:

Kenya Tea Growers Association (KTGA) (47 tea estates)	23 830
Kenya Tea Development Authority (150 000 smallholders and 39 factories)	54 970
Others	2 684
Total	81 484

The agricultural land classed as suitable for tea growing in Kenya is some 287 500 ha (Jaetzold & Schmidt 1983), leaving a vast potential for expansion of tea planting by smallholders.

At present the mean yield of made tea for smallholders and non-KTGA growers combined is 936 kg/ha compared with 2 760 kg/ha for the estates (KTGA). The difference is due to a combination of lower inputs (eg. less fertiliser) and the KTDA policy of aiming for higher value tea by only harvesting the first "two leaves and a bud".

There exists therefore substantial potential for a continuing increase in the quantity of leaf processed by KTDA with a corresponding potential increase in energy needed for withering and drying. The number of KTDA factories has increased as follows:

1982/83	33
1983/84	38
1984/85	39

The Brief foreshadows the addition of a further 10 factories in the foreseeable future.

4.2 Current Fuel Use by KTDA Factories

The quantities of fuel used by each factory (oil and/or fuelwood), the energy value and wood equivalent is shown in Table 4.1 following. The quantities are from KTDA head office records, except for the four wood using factories visited by the Consultant. Comparison of head office and factory records for those factories are as follows for 1984/85.

	Head Office Records		Factory Records	
	Wood cu.m	Oil tonnes	Wood cu.m	Oil tonnes
Kangaita	14 707	Nil	13 646	Nil
Thumaita	11 005	Nil	6 877	102.9
Githongo	7 373	Nil	7 375	Nil
Imenti	7 746	Nil	7 746	Nil

Discrepancies were found between head office and factory fuelwood records at Kangaita (H.O. 8% higher) and Thumaita (H.O. 60% higher while factory used 25% oil unstated in H.O. records). Githongo and Imenti head office and factory fuel records agreed. Due to time constraints the Consultant was unable to check the records of the other three wood using factories at Chebut, Gathuthi and Ragati. Head office records were used in Table 4.1 for the latter and all the oil using factories.

Based on the parameters detailed in Table 4.1 footnotes, and energy consumption records, the 39 KTDA factories would require about 100 000 t/y of Eucalyptus saligna fuelwood at 30% mcwb, assuming 1985 tea drying technologies and efficiency levels.

From 1983/84 data (KTDA 1984) some 99 300 tonnes of wood (equivalent) or 1 410 TJ of energy were used in drying 63 700 tonnes of made tea in 1984/85. This gives an energy intensity about 1.5 tonnes of wood equivalent to 1.0 tonne of tea, or approximately 22 GJ/tonne. The private tea estates have around 1:1 by weight as an efficiency target (approximately 15 GJ/t) which the Study Team also considered to be achievable in the more modern KTDA factories. If this were so the target for fuelwood could reduce to about 65 000 tonnes.

TABLE 4.1 - FUEL USED BY KTDA FACTORIES 1984/85

PROVINCE District	Factory (1)		Fuel t/y	KSh/t (2) (3)	GSE GJ/t	GJ/y	KSh/GJ	Wood Equiv t/y
CENTRAL								
Kirinyaga	Ndima	O	814.9	3 328	42.9	34 959	77.6	2 462
	Kangaita	W	5 076.3	247	14.2	72 083	17.6	5 076
	Kimunye	O	582.6	3 328	42.9	240 834	77.6	1 760
	Thumaita	W	2 943.3	215	14.2	41 796	15.1	3 254
		O	102.9	328	42.9	4 414		
						178 246		12 552
Nyeri	Chinga	O	1 305.7	3 328	42.9	56 015	77.6	3 945
	Iriaini	O	811.3	"	"	34 805	"	2 451
	Gitugi	O	553.1	"	"	23 728	"	1 671
	Gathuthi	W	1 208.7	291	14.2	17 164	20.5	1 209
	Ragati	W	3 194.0	247	"	45 355	17.5	3 194
						177 067		16 430
Muranga'a	Njunu	O	829.0	3 328	42.9	35 564	77.6	2 505
	Makomboki	O	778.8	"	"	33 411	"	2 353
	Ikumbi	O	1 124.4	"	"	48 237	"	3 397
	Githambo	O	993.7	"	"	42 630	"	3 002
	Kanyenyaini	O	719.8	"	"	30 879	"	2 175
	Gatunguru	O	992.4	"	"	42 574	"	2 998
						233 295		16 430
Kiambu	Kambaa	O	526.9	3 328	42.9	22 604	77.6	1 592
	Theta	O	548.8	"	"	23 544	"	1 658
	Mataara	O	1 083.3	"	"	46 474	"	3 273
	Kagwe	O	583.1	"	"	25 015	"	1 762
						117 637		8 285

TABLE 4.1 - FUEL USED BY KTDA FACTORIES 1984/85

PROVINCE District	Factory (1)		Fuel t/y	KSh/t (2) (3)	GSE GJ/t	GJ/y	KSh/GJ	Wood Equiv t/y
RIFT VALLEY								
Nandi	Chebut	W	4 173.5	247	14.2	59 264	17.4	4 174
Kericho	Tegat	0	4 071.3	3 552	42.9	45 959	82.8	3 237
	Kapset	0	1 249.0	"	"	53 582	"	3 773
	Mogogosiek	0	1 826.1	"	"	78 340	"	5 517
	Litein	0	712.7	"	"	30 575	"	2 153
	Kapkoros	0	665.2	"	"	28 537	"	2 010
						236 993		16 690
Kisii	Nyansiongo	0	448.9	3 552	42.9	20 974	82.8	1 477
	Nyankoba	0	640.8	"	"	27 490	"	1 936
	Kiamokama	0	691.3	"	"	29 657	"	2 089
	Nyamache	0	513.1	"	"	22 012	"	1 550
	Ogembo	0	396.7	"	"	17 018	"	1 198
	Sanganyi	0	754.8	"	"	32 381	"	2 280
	Kebirigo	0	946.6	"	"	40 609	"	2 860
	Tombe	0	566.6	"	"	24 307	"	1 712
						214 448		15 102
EASTERN								
Meru	Githongo	W	3 155.6	215	14.2	44 810	15.1	3 156
	Imenti	W	3 315.3	215	"	47 077	15.1	3 315
	Kiegoi	0	556.9	3 552	42.9	23 891	82.8	1 682
	Kinoro	0	470.4	"	"	20 193	77.6	1 422
						135 971		9 575
Embu	Mungania	0	625.2	3 328	42.9	26 821	77.6	1 889
	Rukuriri	0	701.1	"	"	30 077	"	2 118
						56 898		4 007
All Factories						1 409 819		99 285

Notes:

1. Data from KTDA head office records except for direct factory data from consultant visits for Kangaita, Githongo, Imenti and Thumaita.

2. Oil prices at factory supplied by KTDA Head Office 26/9/85.
East of Rift = 3.11 KSh/L, West = 3.32 KSh/L, Kiegoi = 3.32 KSh/L.

3. Fuelwood prices from consultant visits to Thumaita, Kangaita, Githongo and Imenti. Costs for other wood using factories as average of Kangaita, Githongo and Imenti.

5.0 PRESENT AND POTENTIAL FUELWOOD SUPPLY FROM FOREST DEPARTMENT

5.1 Supply to Present Fuelwood Using Factories

At the time of the Consultant's visit to Kenya, fuelwood supply to KTDA was almost 100% from the Forest Department. The KTDA's position regarding fuelwood can be summarised as follows:

- KTDA policy is to convert as many factories from oil to fuelwood as soon as possible, provided a reliable supply can be made available.

- The priority is to convert the following factories as soon as possible: Mataara, Ikumbi, Kanyenyaini, Gatunguru, Chinga, Iriaini, Kimunye, and Mungania. (It is noted that by mid 1986, most of these factories had been converted to dual oil/fuelwood firing).

- Fuelwood supply from the Forest Department (up to 1984/85) to present fuelwood using factories has mainly come from indigenous forest species. With a government decree essentially prohibiting further clearing of indigenous forests, this supply source is expected to disappear.

- Future fuelwood supplies are expected to come mainly from Forest Department plantations, almost exclusively Eucalyptus saligna.

- The KTDA look to the Forest Department as one source of supply. A letter of 12 January 1979 from the Chief Conservator of Forests which includes the following, has raised some expectations from KTDA.

  "Forest Department is planting eucalyptus to meet tea factory requirements with a programme now 2-3 years old. Areas are available for exploitation in vicinity of factories already fully or partially operational on fuelwood (i.e. Ragati, Kangaita, Gathuthi). Forest Department gives assurances of fuelwood for 13 factories (Mataara, Gatunguru, Chinga, Iriaini, Gathuthi, Ragati, Kangaita, Kimunye). For some of the factories above - it may be possible to use fuelwood earlier by making use of indigenous trees felled from areas to be converted to plantations by using thinnings."

- The KTDA General Manager wrote to Chief Conservator of Forests on 20 May 1985 expresssing concern that there is now doubt over fuelwood for 8 factories targeted for conversion to fuelwood and even fear that fuelwood supply may be at risk for the 7 factories already converted to fuelwood from oil.

- KTDA has expressed concern that it is required to compete with other major users of eucalypt plantation resources, especially pole users such as Posts and Telegraphs and the Kenya Power and Lighting Company. The Consultant was advised there were formalised ongoing discussions between the Forest Department and each major user to reach agreement on future allocations. KTDA also expressed concern to the Consultant that plantations ostensibly established to supply KTDA factories had not been very successful and were below expectations. The Consultant was unable to confirm the status of such plantations in the limited time available.

- KTDA advised the Consultant that the primary reason for changing factories to wood was because it continued to be a substantially lower cost energy source. In 1985, at the time of data collection for this study, the equivalent energy cost advantage was over 3:1 in favour of fuelwood. The Consultant has shown in this report how it is feasible to produce fuelwood, under various supply options, at continuingly low energy cost to KTDA.

5.2 Future KTDA Fuelwood Supply Perspective

In order to assess the prospects of the Forest Department as a source of fuelwood supply to KTDA, the Consultant examined the available data on eucalyptus plantations of that Department and compared supply potential with factory requirements. Table 5.1 provides estimates of fuelwood requirements compiled by KTDA and by the Consultant. In terms of tonnes/year the two estimates are close (7% difference). The Consultant has used the KTDA fuelwood yield estimate of 11.85t/ha/y as a reasonable expectation. This is well below the potential of the better upland soils but may exceed present production levels.

The potential fuelwood supply position compared with KTDA demand requirement on a district basis has been developed from Table 5.1 and is shown in Table 5.2.

TABLE 5.1 - KTDA FACTORY FUELWOOD DEMAND AND FOREST DEPARTMENT EUCALYPTUS (E) WATTLE (W) PLANTATION RESOURCES

PROVINCE District	Factory	Fuelwood Demand: KTDA Estimate t/y (1)	KTDA Estimate Area ha (2)	WB Estimate t/y (3)	Forest Department Plantation Supply: Promised to KTDA 1979 Available plant ha	Recomm. ha	Total ha	t/y (4)	Recorded Plantation Areas by Sources: ha 1983 (5)	ha 1984 (5)	t/y 1984 data	ha 1983 (6)	t/y 1983 data
CENTRAL Kirinyaga	Ndima	2 370	200	2 500	0	0	0	0					
	Kangaita	"	"	5 100	0	200 E	200 E	2 400					
	Kimunye	"	"	1 800	0	160 E	160 E	1 900					
	Thumaita	"	"	3 300	0	160 E	160 E	1 900					
		9 480	800	12 600					240	261	3 100	240	2 900
Nyeri	Chinga	2 370	200	3 900	0	200 E	200 E	1 400					
	Iriaini	"	"	2 500	0	200 E	200 E	2 400					
	Gitugi	"	"	1 700									
	Gathuthi	"	"	1 200	148	200 E	348 E	4 100					
	Ragati	"	"	3 200	298	200 E	498 E	5 900					
		11 850	1 000	12 500			14 800		1 402	1 466	17 400	1 198	14 300
Muranga'a	Njunu	2 370	200	2 500	0	0	0	0					
	Makomboki	"	"	2 400	0	0	0	0					
	Ikumbi	"	"	3 400	0	0	0	0					
	Githambo	"	"	3 000	0	0	0	0					
	Kanyenyaini		"	2 200	0	0	250 W	3 000					
	Gatunguru	"	"	3 000	0	500 W	500 W	6 000					
		14 220	1 20C	16 500					33	49	600	30	400
Kiambu	Kambaa	2 370	200	1 600	0	0	0	0					
	Theta	"	"	1 700	0	0	0	0					
	Mataara	"	"	2 300	0	300 W	300 W	3 600					
	Kagwe	"	"	1 800	No data available								
		9 480	800	8 400					902	982	11 700	2 300	27 400
RIFT VALLEY Nandi	Chebut	2 370	200	4 200					243	266	3 200	211	2 500
Kericho	Tegat	2 370	200	3 200	No data available								
	Kapset	"	"	3 800	"	"							
	Mogogosiek	"	"	5 500	"	"							
	Litein	"	"	2 200	"	"							
	Kapkoros	"	"	2 000	"	"							
		11 850	1 000	16 700					993	1 040	12 400	549	6 500

TABLE 5.1 KTDA FACTORY FUELWOOD DEMAND & FOREST DEPARTMENT EUCALYPTUS (E) WATTLE (W) PLANTATION RESOURCES

PROVINCE District	Factory	Fuelwood Demand			Forest Department Plantation Supply							
		KTDA Estimate		WB Estimate	Promised to KTDA - - 1979				Recorded Plantation Areas			
		t/y (1)	Area ha (2)	t/y	Available plant ha	Recomm. ha	Total ha	t/y (3)	ha 1983 (4)	ha 1984 (4)	t/y 1984 data (5)	ha 1983
RIFT VALLEY (Cont'd)												
Kisii	Nyansiongo	2 370	200	1 500	No data	———	available					
	Nyankoba	"	"	1 900	" "	"	"					
	Kiamokama	"	"	2 100	" "	"	"					
	Nyamache	"	"	1 600	" "	"	"					
	Ogembo	"	"	1 200	" "	"	"					
	Sanganyi	"	"	2 300	" "	"	"					
	Kebirigo	"	"	2 900	" "	"	"					
	Tombe	"	"	1 700	" "	"	"					
		18 960	1 600	15 100					0	0	0	na
EASTERN Meru	Githongo	2 370	200	3 200	40	480	520 E	6 200				
	Imenti	"	"	3 300	No data available							
	Kiegoi	"	"	1 700	0	0	0	0				
	Kinoro	"	"	1 400	0	480 E	480 E	5 700				
		9 480	800	9 600					567	639	7 600	436
Embu	Mungania	2 370	200	1 900	0	160 E	160 E	1 900				
	Rukuriri	"	"	2 100	0	0	0	0				
		4 740	400	4 000					134	155	1 800	na
All factories		92 430	7 800	99 300							57 800	

Note (1) 1 cu.m stacked = 0.316 tonnes 30% mcwb
1 tonne = 14.2 GJ GSE
(2) KTDA assumes 10 year rotation
(3) WB = Energy Efficiency in Tea Industry Study Team
Mean Annual Increment (MAI) = 22.5 cu.m/ha/y = 11.9 t/ha/y 30 % mcwb
(4) Forest Department yield estimate from records
(5) Data from Forest Department via World Bank Peri-Urban Fuelwood Project
(6) Data from Forest Department records via Kahuki (1985)

TABLE 5.2 - FUELWOOD SUPPLY - DEMAND BY DISTRICT (Tonnes/Year)

PROVINCE	KTDA Demand (1)		FD Yield (2)	Surplus Deficit	
District	Ratio fuelwood/tea		Potential	Ratio fuelwood/tea	
	1.56:1	1:1		1.56:1	1:1
CENTRAL					
Kirinyaga	12 600	8 100	3 100	- 9 500	- 5 000
Nyeri	12 500	8 000	14 800	+ 2 300	+ 6 800
Muranga'a	16 500	10 600	500	-16 000	-10 100
Kiambu	8 400	5 400	28 300	+19 900	+22 900
	50 000	32 100	46 700	- 3 300	+14 600
RIFT VALLEY					
Nandi	4 200	2 700	2 800	- 1 400	+ 100
Kericho	16 700	10 700	7 100	- 9 600	- 3 600
Kisii	15 100	9 100	0	-15 100	- 9 700
	36 000	23 100	9 900	-26 100	-13 200
EASTERN					
Meru	9 600	6 200	6 000	- 3 600	- 200
Embu	4 000	2 600	1 800	- 2 200	- 800
	13 600	8 800	7 800	- 5 800	- 1 000
All Factories	99 600	64 000	64 400	-35 200	+ 400

Source: Table 5.1

Notes:

(1) The present KTDA fuelwood energy ratio is 1.56 tonnes fuelwood (energy equivalent) to 1 tonne made tea. The target ratio is 1 tonne of fuelwood to 1 tonne made tea.

(2) Estimates of potential yield compiled from Kahuki (1984) data for 1983 (Table 5.1), updated by adding 1984 planting from World Bank Peri-Urban Fuelwood Project data, used for Kisii and Embu Districts.

Assuming all factories are fuelwood operated, Table 5.2 indicates that:

- For Central Province based on present 1.56:1 fuelwood to made tea ratio
  - Nyeri and Kiambu Districts have potential fuelwood yields higher than factory needs
  - Kirinyaga and Muranga'a Districts show a deficit.

  This relative position will remain even if efficiency improves to 1:1, although the overall Province balance will change from a small fuelwood deficit to a substantial surplus.

  The above assumes:

  - All the present growth can be harvested yearly. This is optimistic as the age class distribution is uneven and generally biased towards younger trees, giving a lower sustained supply yield than is indicated by growth of plantations.

  - The areas stated are fully stocked and productive. This is optimistic bearing in mind the view that some Forest Department eucalypt plantations may not be as productive as they could be.

  - All the yield will come to KTDA. This is optimistic as there will be competing demands from other users of telephone, power, building poles, and fuelwood due to proximity to Nairobi.

- It should be economically possible to transport eucalyptus fuelwood from areas of surplus, including neighbouring fuelwood rich regions and utilising otherwise unused returning road vehicle capacity, to areas of deficit in Central and Eastern Provinces assuming 2.0 KSh/t/km or 0.14 KSh/GJ/km. At the relative fuelwood/oil prices in 1985, on an equivalent thermal energy basis, there appears quite substantial potential for the transport of fuelwood from areas of surplus.

- In the Rift Valley Province there are fuelwood deficits, especially in Kericho and Kisii Districts, even if energy efficiencies reach 1:1. This is optimistic and the deficits could be larger.

- In the Eastern Province there is a slight deficit at 1:1 usage ratio.

5.3 Cost of Fuelwood Production

The cost of production for a eucalyptus model was examined by Forest Department for an 8 year rotation. This was updated by the Consultant who also developed a model from Forest Department data for industrial conifer establishment costs. These models which assume 15% interest are detailed in Annexure C2, Tables 2.1, 2.2 and 2.3 and summarised as follows:

	KSh/cu.m	KSh/t	KSh/GJ
8 year rotation	67.53	128.15	9.03
4 year rotation	71.11	134.66	9.49

These costs assume good management and fully stocked plantations which grow at predicted rates of 28 cu.m/ha/y. The KTDA has advised the Consultant that, in practice, the Forest Department plantations have so far performed below these expectations. That level, however, was not able to be determined by the Consultant.

5.4 Institutional Matters

The Forest Department resource needs a more detailed and updated inventory to estimate the amount of fuelwood available. A new long term fuelwood supply commitment could then be made to the various resource users, such as KTDA, based on the resources identified.

Plans should be made by the Forest Department to upgrade its hardwood plantations to maximise output consistent with existing policies which do not allow further felling of indigenous forests to expand forest plantations.

Until the above are attended to, the shortfalls in fuelwood supply to KTDA factories cannot be quantified exactly. However, from Tables 5.1 and 5.2 it is clear there will be supply difficulties to factories in most if not all Districts, even if KTDA is assumed to receive 100% allocation of the Forest Department hardwood plantations.

These shortfalls will therefore need to be met by supply options outside Forest Department. These options are examined later in this Appendix.

6.0 PRESENT BIOMASS USE AND SUPPLY - PRIVATE ESTATES

6.1 Fuelwood Resource

In 1983 there were 23 830 ha under tea production by members of the Kenya Tea Growers' Association (private estates), plus 2 680 ha of "others" apart from the smallholder sector. It is known that the estates of Brooke Bond, East African Produce, George Williamson and East African Acceptance (Kaisugu), with a confirmed planted tea area of 13 900 ha, use plantation grown fuelwoods as an energy source in drying. It is assumed the balance of estates and "others" also use fuelwood exclusively for drying.

Fuelwood plantations are composed mainly of Eucalyptus saligna, although one estate has recently introduced a provenance of E. grandis from Australia which has produced greater yields over the same period.

There is substantial potential for surplus fuelwood production from the private estates as described hereunder.

6.1.1 Improved Efficiency in Drying Tea

Efficiency in drying for the private estates visited is around 1.5t fuelwood (30% mcwb at 14.2 GJ/t GSE) to 1.0 tMT. The target is 1:1 a level which has been achieved using direct drying from wood gasification, and can also be achieved by efficient indirect wood combustion in boilers.

Table 6.1 indicates that a surplus of about 33 000 t/y of fuelwood is potentially available from the private estates through increased efficiency at present production levels . However, given market opportunities for increasing tea sales, the estates preferred option may be to decrease fuelwood area and increase tea area where fuelwood is growing on sites suitable for tea, even though this may not necessarily be in the national interest.

The Consultant understands that on many estates fuelwood plantations have been established on sites less suited to tea. In these cases there may be more opportunity to produce surplus fuelwood for the market as energy efficiency increases. In the Kericho district, however, the Consultant was of the opinion that the fuelwood plantations of the private estates appeared in the main to be on land suited to tea, and hence the opportunity for producing surplus fuelwood may be limited.

TABLE 6.1 - ESTIMATED FUELWOOD YIELD AND USE FROM TEA ESTATE PLANTATIONS (t/y)

District	Made Tea (1)	Usage/ Efficiency Level 1.5:1	1:1	Possible Surplus
Kericho	33 387	50 081	33 387	16 694
Sotik	7 764	11 646	7 764	3 882
Nandi	18 477	27 716	18 477	9 239
Kiambu/Limuru	6 119	9 179	6 119	3 063
TOTAL	65 747	98 621	65 744	32 877

Note: (1) Mean Estate made tea yield = 2 759 kg/ha for 1983 (KTGA 1984)

6.1.2 Improved Fuelwood Plantation Yields

(a) Genetic Material

Fuelwood yields on the private plantations are already high by world standards. Two major estates have supplied data, summarised in Table 6.2 below. The most conservative yield is 23 t/ha/y for an 8 year rotation of Eucalyptus saligna with wood of 527 kg/cu.m density at 30% mcwb giving 14.2 GJ/t GSE. One estate reports increasing yield by 56% from 48cu.m/ha/y (25.3 t/ha/y) using E. saligna, to 75cu.m/ha/y (39.5 t/ha/y) using selected seed of E. grandis collected in Australia.

TABLE 6.2 - EUCALYPTUS PLANTATION YIELDS - KERICHO DISTRICT

Tea Estate	Eucalyptus Species	Yield cu.m/ha stacked	Age Years	MAI/ha/y Cu.m solid(i)	MAI/ha/y Tonnes(2)
A.	Saligna	600	7.5 (7 to 8)	48.0	25.3
	Grandis	1 000	7.5 (7 to 8)	75.0	39.5
B.	Saligna	750	8	56.3	29.6

Notes: (1) cu.m stacked = 0.6 cu.m solid (over bark volume)
(2) Density for E. saligna at 50% mcwb = 738 kg/cu.m
25% mcwb = 492 kg/cu.m
at 0% mcwb = 369 kg/cu.m

Wood at 30% mcwb and 527 kg/cu.m density has been used as the standard for fast grown upland eucalyptus.

Brazilian experience has given yields of up to 85 cu.m/ha/y for selected clones of E. grandis and expectations from current developments are to raise Mean Annual Increment (MAI) to 110 cu.m/ha/y (Mercado 1985). However these are exceptional yields, on good sites and with high technology and large fertiliser inputs. They do indicate that the Kericho district, with less technology and fertiliser only in Year 1, must rank with the world's most naturally productive sites for eucalyptus (and other species). Higher yields are believed possible utilising Brazilian methods of genetic selection through clonal development by vegetative propagation. This would be a useful means of increasing fuelwood production where land is very limited. A preferred social option would be to encourage the smallholders to produce market fuelwood where possible as an added economic benefit to farm income. This option is addressed in Section 8.

(b) Changing Plantation Management Methods

Present spacing of trees varies from 2.75m x 2.75m to 1.5m x 1.5m for the major estates. It is possible to increase yield by decreasing spacing between trees provided the rotation is decreased. A yield of 29.6 t/ha/y with E. grandis at 2.7m x 2.7m spacing, that is 1325 trees/ha on 7 to 8 year rotation should be capable of significant increase by planting say 5000 trees/ha on a 4 year rotation. This would also produce a smaller diameter stem which is far more suitable for use as fuelwood.

Production of trees of smaller diameter on a shorter rotation allows the use of smaller and less costly fuel preparation plant. The shorter rotation does, however, reduce fuelwood production.

The Consultants propose elsewhere in the report that for high efficiency combustion, fuelwood should be in a particle form rather than the present large (say 5-10 kg) pieces. Reduction of fuelwood by chipping or hogging, followed by firing in a cyclonic combustion chamber, allows greater combustion efficiency and hence reduced fuel consumption to be achieved.

6.2 Cost of Fuelwood Production - Standing Tree

Two major tea estates provided data on costs of establishing eucalyptus plantations and producing fuelwood. Details are given in Annexure C2 Tables 2.5, 2.6, and summarised in Table 10.1. Costs for comparable models using an 8 year rotation and 15% interest give similar production costs for these estates shown in Table 6.3.

TABLE 6.3 - FUELWOOD COSTS

Estate	m^3/ha/y	KSh/m^3	KSh/t	KSh/GJ	KSh/ha/y
A	56.2	31.88	60.52	4.26	
B	48.0	56.39	107.00	7.54	
Mean	52.1	44.14	83.76	5.90	2 300

6.3 Opportunity Cost of Fuelwood Production

The gross return from estate tea growing is of the order of 50 000 KSh/ha/y with green leaf at say 5 KSh/kg. This is to compared with an estimated cost of 2 300 KSh/ha/y for fuelwood in standing tree, or 7 300 KSh/ha/y when harvesting and transport costs are added (see Table 10.1 for 8 year model).

On this basis the opportunity cost to the estates for wood are likely to be too high to warrant continuing to grow fuelwood where tea can replace it as a crop. Therefore the estates may not become a significant source of surplus fuelwood available to KTDA factories.

7.0 POTENTIAL OF FUELWOOD SUPPLY FROM UNDERUTILISED PUBLIC LANDS

7.1 Opportunities

In many countries plantable land exists in road reservations along highways and, to a lesser extent, along secondary roads. There are also small areas unutilised around public buildings such as schools, along railways, and in stream reservations. India has pioneered the successful use of such lands in its extensive social forestry programmes for the production of fuelwood, poles and other community wood products. The tobacco company, BAT, has already made some use of such lands in Kenya by planting along the roadside and other public areas (Kuloki 1982). KTDA has an opportunity to develop a similar programme, particularly along roads leading to and through the highlands close to tea growing areas where soils are generally deep and of high fertility.

Such programmes would require a survey of land availability and agreement by the various public sector authorities responsible for administering these lands. It could also involve local communities which may be invited to share to some extent in the costs and benefits. It is proposed the main beneficiaries should be the KTDA tea factories which should initiate and manage the programmes.

7.2 Roadside Plantings

Preliminary estimates were made of lengths of main road reservations which could be candidate locations for planting fast growing fuelwood trees. Distances were estimated from a 1:1 000 000 scale roadmap utilising 4 rows of trees spaced 1 metre in the row and 2 metres between rows at a stocking of 5000/ha. The spacing is somewhat arbitrary and could be decreased to give an increased biomass yield per year.

The estimated yield for selected main roads is up to 25 000 t/y. Yields were conservatively estimated by the Consultant based on Kenya experience and guided by agro-climatic data of Jaetszold & Schmidt (1983).

7.3 Other Public Lands

In addition to the potential main roads yield, there are many secondary roads along which one or more rows of trees could be planted in an arrangement between adjacent farmers and an appropriate government agency. There are also other public lands under the control of Provincial and/or District Councils and other agencies. This area is unknown, and should be inventoried, but is arbitrarily estimated for reporting purposes at 500 ha in and adjacent to the tea growing areas. This could yield a potential further 5 000 t/y which, when added to the possible 25 000 t/y from roadside plantings, could provide up to 30 000 t/y or nearly one third of the estimated fuelwood needs for all KTDA factories.

TABLE 7.1 - POTENTIAL FUELWOOD YIELD FROM PLANTINGS IN ROADSIDES AND OTHER PUBLIC LANDS t/y

1. Roadside Plantings - Main Roads

PROVINCE	km	ha/km 4 rows	ha	m^3/ha/y (1)	t/y 4 rows
CENTRAL					
Thika-Muranga'a (Rainfall 900-1200mm)	40	4	160	20	1 686
Muranga-Nyeri (Rainfall 900-1200mm)	40	4	160	20	1 686
Muranga-Embu (Rainfall 1200mm)	30	4	120	25	1 581
Nakuru-Kericho	100	4	400	30	6 324
					11 277
EASTERN					
Embu-Meru (Rainfall 1200-1400mm)	80	4	320	30	5 059
Meru-Maua (Rainfall 1200-1400mm)	40	4	160	30	1 686
					6 745
RIFT VALLEY					
Kericho-Kisii	90	4	360	35	6 640
TOTAL					24 662
					say = 25 000

2. Other Roads, Other Public Land

Includes schools, other public buildings, town commons, railway lines, streambank reserves etc. The available area is taken as 500 ha x 20cu.m/ha/y. say = 5 000 t/y

Total preliminary estimate = 30 000 t/y

Source: Preliminary consultant estimate from 1:1 million scale map and field impressions. Requires field survey.

(1) Yield estimate of consultant based on rainfall and agro-climatic data of Jaetzold v Schmidt (1983).

7.4 Cost of Fuelwood Production

The plantation should be fenced for say 4 years to prevent animal damage. The fence would be the major plantation cost, but it could be relocated and used for at least one and possibly two subsequent plantings. The fencing cost is estimated at:

500m/ha of fencing @ half of 25 KSh/m for a 6 wire fence (2 barbed 4 plain) = 6 250/ha
For 4 yr rotation @ 15% = 91.09 KSh/cu.m at 30 cu.m/ha/y

Using the 4 year smallholder cost model:
wood production cost = 61.90 + 91.09 = 152.99 KSh/cu.m
Delivered cost 111.95 + 152.99 = 264.94 KSh/cu.m
= 502.73 KSh/t
= 35.40 KSh/GJ

Note: (1) Tables 10.1 and Annexure C2 Table 2.7.

This is an expensive option compared with the alternatives, but at 36 KSh/GJ delivered is still only about half (on a financial cost basis) of 1985 energy costs from oil.

7.5 Institutional Matters and Constraints

The use of roadside land, is practised in other developing countries, would be a departure from current practice and would clearly pose complex social problems as to land usage and priorities which lie beyond the scope of this report. Nevertheless the agricultural opportunity exists, and it is therefore put forward as one of the options for fuelwood supply enhancement that should be taken into overall consideration.

Roadside planting would naturally need agreement by the Ministry of Highways and Communications, as well as by all of the appropriate local government agencies. It would also significantly affect local people whose views would need to be canvassed, and who should be involved in planning and execution, and should receive some of the benefits. The local people would be in a position to guarantee the security of the project, mend fences and see to the welfare of the plantation. Plantings on roadsides and unused public land could also serve as a catalyst to small-holder production of fuelwood, especially after the initial cash flow, provided market prices rise considerably above present levels. The BAT model along roadsides and underutilised public lands appears to be successful and should be studied to identify the obvious problems which inevitably arise in regard to ownership, management, protection.

8.0 POTENTIAL FOR FUELWOOD SUPPLY FROM SMALLHOLDERS

8.1 Smallholder Land Use in the Highlands

The Highlands of Kenya, classed as suitable for tea and coffee growing, have an elevation around 2000 m with generally fertile soils of volcanic origin. These areas have day temperatures in the range 16°- 26°C, an absence of frosts and an annual rainfall 1200-2000 mm. The Kericho tea growing areas have extremely high potential for plant growth.

Because of the favourable climatic conditions and land capability, the rural population is dense and farm sizes small in the region where KTDA factories are located. There is a size variation from 1.1 ha in the Kisii District to 11.5 ha in the Nandi District, as shown in Table 8.1 below.

TABLE 8.1 - SMALLHOLDER FARM SIZE AND TEA PLOT AREA BY DISTRICTS

District	Mean Farm Size ha (1)	Mean Farm Tea Plot Size ha (2)
Kericho	n.a	0.39
Kisii	1.1	0.32
Nandi	11.5	0.36
Kiambu	3.0	0.49
Muranga'a	3.0(3)	0.40
Nyeri	2.8	0.39
Kirinyaga	2.2	0.38
Embu	2.0	0.35
Meru	2.1	0.40

Note: (1) Jaetzold & Schmidt 1983
(2) KTDA Annual Report 1983/84
(3) Assumed

8.2 Present Biomass Resource

Work carried out by the Beijer Institute in the Kenya Highlands indicates there is between 10% and 30% of the smallholder farms with some form of permanent biomass resource. Beijer staff suggested 10% biomass cover as a safe figure for the Consultant to use, with between 2% and 8% of the farm under permanent or cultivated biomass as hedge, fruit trees, or woodlot. In the tea areas it was found that the higher the tea percentage, the higher was the woodlot percentage; this may indicate the farmers are reacting to market conditions for fuelwood as a cash commodity.

It is said that 2% as woodlot is "dedicated" by market forces. Beijer studies, as exampled by Table 8.2 indicate that woodlots are kept in an uneven aged condition by selective harvesting of trees for building poles and fuelwood on a 4 year average cutting cycle or coppice rotation. The yield can be safely taken as 30 cu.m/ha/y in the highly productive Tea and Tea-Coffee Zones (Jaetzold & Schmidt).

Tree diameters of 8 to 10 cms (breast height, over bark) are currently harvested on farms and are suitable for either poles or fuelwood. The size is appropriate for the proposed method of chipping and hogging, followed by fluidised injection into a cyclonic combustion chamber, the method of firing small boilers more efficiently on woodfuel proposed in this report.

TABLE 8.2 - WOODY BIOMASS (WB) EXISTING IN TEA GROWING AREAS

Area	Pop'n Density	Farm Size ha	Tea %	Woodlot %	WB Planted %	WB Total %	WB Opportunities %
North Kisii	432	0.8	9.5	12.6	14.0	17.7	3.7
South Kisii	366	1.0	5.7	9.5	11.1	16.0	4.9
Muranga'a	523	1.1	18.4	7.0	9.1	17.6	8.5
Kiambu	430	1.9	15.3	7.8	15.2	30.7	15.5

Source: Personal communication with P. Bradley of the Beijer Institute - Kenya Woodfuel Project. From survey data 1985.

8.3 Potential Resource for KTDA

It has been assumed from data provided to the consultants that, conservatively, between 2% and say up to 5% of typical farm area could be available for market fuelwood production, and which could be accessed by existing KTDA factories. These factories offer a market of up to around 100 000 t/y of fuelwood at present fuel efficiency levels. It is however well recognised that this is an average figure, and will not be equally true for all districts. Indeed in some districts of very high populating density, land priorities for subsistence forming and animal husbandry may be well exert prior claim. Furthermore current (but not future) market prices for fuelwood may not be seen to provide sufficient incentive to plant wood as a cash crop. Nevertheless the opportunity has been identified by researchers and is reported upon here.

The Tea, Tea-Coffee and Coffee Zones (Jaetzold & Schmidt 1983) are considered suitable for supply of fuelwood to KTDA factories. Relevant areas are presented in Table 8.3. Potential land available for growing market fuelwood for KTDA factories was assumed at 2% and 5% levels of farm area with growth at 15.8t/ha/y for Tea and Tea-Coffee Zones and at 13.2t/ha/y for the Coffee Zone. The total potential fuelwood yields were then compared with the KTDA factory needs from Table 4.1 with conclusions as follows:

1. In aggregate there is a potential for all the zones to oversupply all KTDA factories by a factor of:

2.4	times	at	2%	level	at	present energy efficiency	
3.7	"	"	"	"	"	potential "	"
5.9	"	"	5%	"	"	present "	"
9.2	"	"	"	"	"	potential "	"

   This would require smallholder participation of around 42% , 27%, 17% and 11% respectively.

2. The Tea and Tea-Coffee Zones in the Districts in Central Province would be unable to meet present needs at 2% level, even with 100% participation. However, adding the Coffee Zone would result in substantial oversupply.

3. The Tea Zone alone in all Districts of Rift Valley Province could potentially oversupply KTDA needs at the 2% level with 100% participation.

4. The Tea and Tea-Coffee Zones in Districts in Eastern Province would undersupply at 2% but substantially over supply by the addition of the Coffee Zone.

5. If mean factory fuelwood requirements are say 100 000 t/y for 39 factories then typically a single factory might require up to 2 500 t/y of fuelwood. This could be provided from about 160 ha (at 30 cu.m/ha/y) in Tea and Tea-Coffee zones, and from about 190 ha (at 25 cu.m/ha/y) in a Coffee zone.

TABLE 8.3 - POTENTIAL FOR FUELWOOD PRODUCTION BY AGRO-ECONOMIC ZONES

t/y (1) Compared with KTDA Factory Needs

PROVINCE District fuelwood/MT	Tea Zone ha(2) ('00)	Tea Zone t/y 2% (3)	Tea Zone t/y 5%	Coffee-Tea Zone ha ('00)	Coffee-Tea Zone t/y 2% (3)	Coffee-Tea Zone t/y 5%	Coffee Zone ha ('00)	Coffee Zone t/y 2% (4)	Coffee Zone t/y 5%	Total ha ('00)	Total t/y 2%	Total t/y 5%	Factory Fuelwood Needs t/y by Ratio Fuelwood/Made Tea (5) 1:1.56	Factory Fuelwood Needs t/y by Ratio Fuelwood/Made Tea (5) 1:1
CENTRAL														
Kiriyaga	38	1 200	3 000	124	3 900	9 800	225	5 900	14 900	387	11 000	27 000	12 600	8 100
Nyeri	189	6 000	14 900	61	1 900	4 800	380	10 000	25 000	630	17 900	44 700	12 500	8 000
Muranga'a	344	10 900	27 200	261	8 200	20 600	548	14 500	36 200	1 153	33 600	84 000	16 500	10 600
Kiambu	160	5 100	12 600	120	3 800	9 500	483	12 800	31 900	763	21 700	54 000	8 400	5 400
		23 200	57 700		17 800	44 700		43 200	108 000		84 200	210 400	50 000	32 100
RIFT VALLEY														
Nandi	221	7 000	17 500	314	9 900	24 800	93	2 500	6 100	628	19 400	48 400	4 200	2 700
Kericho	955	30 200	75 400	255	8 100	20 100	508	13 400	33 500	1 718	51 700	129 000	16 700	10 700
Kisii	623	19 700	49 200	995	31 400	78 600	22	700	1 500	1 640	51 800	129 300	15 100	9 700
		56 900	142 100		49 400	123 500		16 600	41 100		122 900	306 700	36 000	23 100
EASTERN														
Meru	96	3 000	7 600	165	5 200	13 000	565	14 900	37 300	826	23 100	57 900	9 600	6 200
Embu	11	300	900	84	2 700	6 600	125	3 300	8 300	220	6 300	15 800	4 000	2 600
		3 300	8 500		7 900	19 600		18 200	45 600		29 400	73 700	13 600	8 800
TOTAL	2 637	83 400	208 300	2 379	75 100	187 800	2 949	78 000	194 700	7 965	236 500	590 800	99 600	64 000

Source: Agro-economic areas from Jaetzold & Schmidt (1983).

Note: (1) Personal communication from Beijer Institute staff Nairobi (Kenya Woodfuel Development Project) indicates 10% to 30% of upland smallholder farms are covered with biomass. With a figure of 10% and assuming levels of 2% and 5% of farm biomass area presently underutilised a potential reservoir for market (KTDA) fuelwood could be made available.

(2) Areas of tea estates have been deducted (see KTGA 1983 areas)

(3) Assumed yield 30 cu.m/ha/y or 15.8 t/ha/y 30% mcwb for tea and Tea-Coffee Zones.

(4) Assumed yield 25 cu.m/ha/y or 13.2 t/ha/y 30% mcwb for Coffee Zone.

(5) From Table 4.1.

Assuming 100% farmer participation the quantity of fuelwood required for each factory can therefore be produced theoretically within the Tea and Tea-Coffee Zones as follows:

- Assuming 2% of farm area under woodlot, the total farm area required equals 7900 ha or 79 square kilometres, located within 5 km radius of the factory.

- Assuming 5% of farm area under woodlot, 3 200 ha or 32 square kilometres of farm area located within 3.2 km radius of the factory are required.

- If farmer participation is reduced to 50%, for 2% and 5% of farm area under woodlot, the radius around the factory would be extended to 7 km and 4.5 km respectively in order to meet factory fuelwood needs.

6. From 5. above it is reasonable to assume a mean fuelwood transport distance to factory of between 2 and 4 km, a very small added cost to that of the estimated smallholder model production cost in Table 8.4. Currently green leaf is purchased from farms within 3 kms of factory buying centres. Accordingly, it should be quite possible for many of the tea growing farms to be encouraged to produce fuelwood for their own factory.

8.4 Cost and Returns of Fuelwood Production - Standing Tree

Farmers have been growing fuelwood trees (Note: Fuelwood can be produced from other than trees), especially Eucalyptus, successfully for many years according to staff of Beijer Institute in Nairobi. Good quality seedlings raised under coffee which has been fertilised, or on old house floors of high fertility, are examples of low cost farmer technology. The impression gained by the Consultant is that:

1. Farmers are quite capable of producing market fuelwood in woodlots.

2. Farmers however need some advice and improved seed supply (especially more suitable species and varieties).

3. Farmers need assurance of a market with the local tea factory and of an acceptable profit margin.

In the absence of real data from farmer records, the Consultant has taken selected elements from three models provided by major estates of their costs of Eucalyptus fuelwood production and KTDA data. Excluding costs of fertiliser and weedicide the actual cost is almost entirely labour which can be shadow-priced at a Consultant estimate of 60%.

The model allows an interest charge on the imputed cost of the farmer's labour as a return to the farmer for growing the standing tree. Providing the farmer still has unutilised time within the family he may carry out the harvesting and stacking at farm gate or roadside. Delivery of cut wood to the factory by animal cart transport may provide an additional income option over short distances. Expected farmer income is given in Annexure C2 Table 2.8.

TABLE 8.4 - FARMER INCOME FROM FUELWOOD AT FULL LABOUR COST

	4 Year Rotation at 15%	
	KSh/m^3	KSh/ha/y
Wood Production	61.90	1 857
Harvesting	44.65	1 340
TOTAL	106.55	3 197

8.5 Opportunity Cost of Fuelwood Production

Based on present prices and opportunities it is more profitable for smallholders to grow green leaf than market fuelwood. A present green leaf yield of 3 770 kg/ha for an annual cost of say 5 300 KSh/ha/y, and a net return of say 22 000 KSh is to be compared with 2 900 KSh for fuelwood.

8.6 Institutional Matters and Constraints

If a farmer had a choice between growing tea and fuelwood, he would grow tea as it is far more profitable. However, there are about 265 000 ha of land in Kenya classed as suitable for tea growing (Jaetzwold & Schmidt 1983) of which over 200 000 ha is still unplanted. Similarly large areas unplanted to tea or coffee occur in the Tea-Coffee and Coffee Zones, and opportunities for expanding tea or coffee plantings are severely constrained by limited export opportunities. Because of this constraint it is assumed that there would be some farmer interest in growing fuelwood if KTDA were to promote this actively as a smallholder programme and offer guaranteed market opportunities in the same manner as for the green leaf. To proceed, the following matters would require to be addressed:

1. KTDA should decide how much fuelwood is needed from the smallholders, after reviewing all other options suggested in this report.

2. KTDA should carry out a feasibility study into smallholder fuelwood production.

3. Assuming the project appeared feasible, it would then be necessary for KTDA to:

   - Carry out a research and demonstration woodlot programme.

   - Establish an advisory service for farmers in appropriate methods of developing woodlots.

   - To distribute seed and seedlings of the most suitable species for factory use and for farming systems.

   - Formulate a marketing structure, as for green leaf via buying centres.

9.0 BIOMASS FROM CROP RESIDUES

9.1 Forest Residues of Forest Department

9.1.1 Resource Overview

The harvesting of indigenous forests is now very limited, and according to Presidential decree will virtually cease. For the purposes of this report consideration of forest residues must therefore be restricted to plantation material.

Hardwood plantations, mainly of Eucalyptus, have been established largely to provide poles and fuelwood. This resource has been covered in an earlier chapter. Accordingly, forest residues to be considered can only be Forest Department plantation material, mainly conifers (Pinus patula, Cupressus lusitanica and some P.radiata.). Sources include residues from harvesting left within the forest, and sawmill or other processing residues generally left outside the forest.

For practical purposes harvesting resources following removal of sawlogs, ply logs and pulp logs have been assigned zero value for conifer plantations. Tree tops can be utilised by local people for fuelwood, either formally or informally. As much as possible should be retained in the forest, however for environmental purposes, especially nutrient recycling.

9.1.2 Sawmill Residues

The Forest Department indicated that there were limited unutilised sawmill residues as about 85% of mills are located outside the forests close to townships, with the following pattern of residue use:

Residue Composition	Sales - Mills near Towns
12% bark	100% sold attached to slabs
15% sawdust	Around 80% sold in areas close to towns
33% offcuts	100% sold as construction panels; slabs for fencing

60% of initial volume

For the 15% of remote sawmills the Forest Department estimates (Kahuki 1984) indicate a current domestic requirement of about 600 000 cu.m/y plantation roundwood for sawn timber and wood based panels. Assuming only the sawdust therefore is not currently completely used, the available sawdust would be as follows:

Total sawdust make 15% x 600 000 cu.m		=	90 000 cu.m/y
Sawdust available			
. Remote mills	15% x 90 000 x 100%	=	13 500
. Close mills	85% x 90 000 x 20%	=	15 300
Total available		=	28 800 cu.m/y
At density of say 0.5t/cu.m at 30% mcwb		=	14 000 t/y

Because sawdust oxidises, there would be a limited long term accumulation and the total sawdust inventory is estimated at say 30 - 50 000 tonnes, much of which may be unsuitable. Forest Department records indicated (Table 9.1) that there are 100 sawmills in the KTDA districts but with under 200 000 cu.m/y log input the usable sawdust residue is therefore assumed at say 100 000 t/y, and widely scattered.

FOREST DEPARTMENT RECORDS OF SAWMILLS IN THE KTDA DISTRICTS

TABLE 9.1 - SAWMILL LOG INTAKE IN KTDA DISTRICTS 1983/84

PROVINCE District	Log Volume m^3/a	No of Mills
CENTRAL		
Kirinyaga	2 390	11
Nyeri	46 195	11
Muranga'a	-	-
Kiambu	77 520	16
	126 105	38
RIFT VALLEY		
Nandi	2 000	1
Kericho	35 260	16
Kisii	-	-
	37 260	17
EASTERN		
Meru	16 822	41
Embu	1 060	4
	17 882	45
All Districts	181 247	100

The potential use of sawdust by KTDA, therefore, requires considerably more study and collection of data. Nevertheless Table 9.1 does indicate that, for a number of factories placed reasonably near to sawmills (notably in the Districts of Nyeri, Kiambu, Kericho, Meru), they may well be viable opportunities. This report therefore commands further site and factory specific study into this interesting option.

9.1.3 Conifer Plantation Thinnings

A major opportunity for KTDA exists, and which should be explored with unutilised non-commercial thinnings. Forest Department records given to the Consultant indicated about 240 000 cu.m of pulpwood was harvested in 1983 while Kahuki (1984) suggests the following yield potential from conifer plantations.

TABLE 9.2 - PROJECTED PULPWOOD YIELDS FROM THE PULPWOOD MANAGEMENT DISTRICTS (1)

Year of Planting	Year of Harvesting	Yield m^3
1965	1983	184 000
1966	1984	291 000
1967	1985	529 000
1968	1986	960 000
1969	1987	614 000
1970	1988	614 000
1971	1989	871 000
1972	1990	918 000

Note: (1) Districts of Kakamega, Nandi, Uasin Gishu

Investigations have been made into establishment of a chemical pulpmill at Thika, however the Forest Department advised that the economic viability does appear doubtful.

It is possible that non-commercial thinnings could be made in these pulpwood plantations, chipped in the forest and transported to KTDA factories, at least in cases where transport distances would not render the operation uneconomic. As of 1985 there appeared to be about 140 000 t/y of unused conifer wood being produced which is considerably more than the total demand of KTDA even if all factories were converted to fuelwood firing.

9.2 Other Residues

Kahuki (1984) has reviewed Kenya's biomass resources and the availability and use is summarised in Table 9.3. Rice husks are immediately available at the cost of loading and transport. Modification would be needed to factory furnace systems to accept rice husks as a fluidised particulate fuel. Bamboo is available but its community use and cost of harvesting and transport would need to be examined.

TABLE 9.3 - BIOMASS RESOURCES FROM CROP RESIDUES

Resource	t/y	Availability and Use	Location
Rice husks	6 000	Available and being burnt	Embu district
Bagasse	290 000	Used as fuel in sugar mills	Various
Bamboo	113 000	Available if economic to harvest	Central 52 000 ha Western 11 500 ha Rift 40 400 ha Eastern 9 000 ha
Straw	Not known	Used as animal feed	Various
Sisal	50 000	Used for sack, ropes, twine	Various

Source: Kahuki C.D 1984 "Raw material resources for obtaining fibrous products for production of paper and board. Forest Department Nairobi".

9.3 Cost of Crop Residues

Sawdust		KSh/t	KSh/GJ
Assume royalty		Nil	
Assume cost of loading, say		10.00	
Transport per km		2.00	
Delivered cost	10 km	30.00	2.1
	100 km	210.00	14.8
	200 km	410.00	28.9

Conifer Thinnings

Assume cost as for present Forest Department plantation eucalyptus

Delivered cost	10 km	291.00	20.5
	100 km	491.00	34.6
	200 km	691.00	48.7

Rice Husks

As for sawdust.

Bamboo

Probably similar to conifer thinnings but add say 20% to costs.

10.0 SUMMARY OF BIOMASS RESOURCE OPTIONS AND COSTS

10.1 Pricing of Biomass Energy

The mid 1985 cost of energy from fuel oil derived to KTDA factories was about 77.6 KSh/GJ for East of Rift and 82.8 KSh/GJ for West of Rift plus Kiegoi (Meru district).

Based on these oil energy costs, the delivered costs of fuelwood shown in the summary Table 10.1 could be allowed to rise by a factor of 3.3 to 3.6 for the smallholder model, 2.2 to 2.3 for the public lands model and 3.2 to 3.5 for the Forest Department model. However, in considering an acceptable delivered cost for fuelwood KTDA must take into account current 1985 market prices for fuelwood in the main centres. These are:

	KSh/t	KSh/GJ
Nairobi	250	17.61
Kisumu	220	15.49
Nakuru	200	14.08
Eldoret	170	11.97

Source: MOERD Nairobi 1985

All the fuelwood models developed in this report give a delivered cost to KTDA factories higher than the highest market price (Nairobi). It is generally agreed that present market prices are far too low, and must rise at least to meet production costs. The low prices probably reflect the philosophy of fuelwood being a commodity, until recently "free" except for the labour cost of gathering. With tightening policies, which will restrict access to natural forest resources, dependence of supply would shift to plantation fuelwood crops which would have to be sold at least at prices indicated in the Consultant's models.

It is concluded that KTDA would need to accept the indicated model costs in Table 10.1. An economic case could be argued for giving smallholders a price subsidy above the indicated prices if an additional incentive were required to encourage farm-based commercial woodlot production. The economic case could be based on say a 20% shadow cost added to the KTDA price of oil because of foreign exchange shortage.

A summary of fuelwood quantities and costs by production models is given in Tables 10.1 and 10.2.

10.2 Conclusions on Supply Options for KTDA Factories

1. KTDA policy is to obtain the maximum supply of fuelwood from the Forest Department. This would in due course be entirely from fuelwood plantations, mainly eucalyptus, as indigenous forest supplies become unavailable. Indications are that KTDA would be able to negotiate a share (assumed at 50%) of projected yield from these Forest Department fuelwood plantations, though the percentage should be confirmed and Forest Department yield be subject to inventory.

2. Private estates could have a potential fuelwood surplus as energy efficiency improves. However, not only are the estates likely to prefer to plant their surplus fuelwood areas with tea but also the opportunity cost of the surplus fuelwood is likely to make this energy form too costly for KTDA.

3. Underutilised public lands such as roadsides and other areas have been successfully used by BAT for fuelwood production. It is possible they could provide 25% or more of fuelwood needs for all 39 KTDA factories at current efficiency levels. The price of delivered energy could however be twice as high as for other models mainly due to the high cost of fencing to protect roadside plantings. However, this supply model could deliver energy at about half the 1985 cost of oil, and the experience of BAT in using such a model would make it worth detailed examination by KTDA.

4. The smallholder model could theoretically supply more fuelwood than all 39 KTDA factories would require at current efficiency levels. The KTDA factory system supplied by 150 000 farmers is by international standards one of the most successful smallholder projects. There is no theoretical constraint for the same smallholders to produce fuelwood for KTDA factories, providing the profit margin was adequate and the market assured. The smallholder model could produce fuelwood at no greater cost than from the Forest Department and with wider spread of socio-economic benefit. Some reservations are held by KTDA concerning this model which will require very careful evaluation. The model would need testing and farmers' reactions determined. A programme for supplying say 25% to 50% of KTDA needs should be investigated.

5. Crop residues and sawdust could provide some or, in fact, all of KTDA needs. 6 000 t/y of rice husks are currently being burnt to waste and could be used with appropriate combustion plant modification. Coffee husks are already used for combustion in industries in Nairobi, while sawdust also finds some industrial use. However with sawdust there is still quite a substantial surplus which could be made available. There would appear to be a surplus of about 140 000 t/y of Forest Department coniferous roundwood available due to the proposed pulpmill project not proceeding. The economic availability of this resource, as well as non-commercial thinnings, should be explored by KTDA.

6. A number of biomass and biomass residue supply options have been identified which in total could supply energy to all 39 KTDA factories at well below the 1985 cost of oil energy. Further investigative work would need to be carried out by KTDA on these options, and the Forest Department would need to carry out the following tasks.

   - Inventory all fuelwood plantations and review plantation management programmes.

   - Make clear decisions on future allocations of plantation fuelwood to users such as KTDA.

   - Assuming inventories of conifer plantations are of adequate standard, make clear decisions regarding allocations of roundwood (other than for sawlog or plylog) for uses such as pulp logs and fuelwood.

TABLE 10.1 - SUMMARY OF FUELWOOD COST IN KSh BY PRODUCTION MODELS FOR EUCALYPTUS AT 15% INTEREST BUT EXCLUDING PROFIT MARGIN

Model	Standing Tree			Harvesting			Transport & Stacking			Total Delivered		
Cost Ksh per:	m^3	t	GJ	m^3	t	GJ	m^3	t	GJ	m^3	t	GJ
Forest Department (1)												
8 y rotation	67.53	128.15	9.03	44.65	84.72	5.97	67.30	127.70	8.99	179.48	340.57	23.99
4 y rotation	71.11	134.66	9.49	44.65	84.72	5.97	67.30	127.70	8.99	183.06	347.09	24.45
Estate A (2)												
8 y forest site	31.88	60.52	4.26	30.83	58.50	4.12	83.33	158.12	11.13	146.04	277.14	19.52
Estate B (3)												
8 y forest site	56.39	107.00	7.54	40.92	77.65	5.47	99.06	187.97	13.24	196.37	372.62	26.24
KTDA												
Factory model (4)												
Eucalyptus	19.58	varies					67.30	127.70	8.99	153.36	291.00	20.5
Native	19.58	varies					54.66	127.70	8.99	92.02	215.00	15.1
50% of each	19.58	varies					60.98	127.70	8.99	122.68	247.00	17.4
Smallholder Model												
Eucalyptus												
4 y full price	61.90	117.46	8.27	44.65	84.72	5.97	67.30	127.70	8.99	173.85	329.89	23.23
Public Lands Model												
4 y full price	152.99	290.31	20.44	44.65	84.72	5.97	67.30	127.70	8.99	264.94	502.73	35.40

(1) For royalty 8 y see Annexure C2 Table 2.2 and for 4 y see Annexure C2 Tables 2.3 and 2.4.
Uses E. saligna 28 cu.m/ha/y but uses KTDA transport costs as realistic.
(2) Uses E. saligna 56.2 cu.m/ha/y.
(3) Forest site = clear forest c/w grassland site 8 y uses E. saligna 48 cu.m/ha/y. 7.5 y rotation uses E. grandis = 80 cu.m/ha/y.
(4) Derived from fuelwood using factories Kangaita, Githongo, Imenti. See Table 4.1.
(5) Derived from Annexure C2 Table A2.7. Uses Eucalyptus 30 cu.m/ha/y. Labour shadow priced at 60%.
(6) Imenti factory harvesting cost. Equates with Forest Department costs (Kimini & Ombok 1983).

TABLE 10.2 - BIOMASS SUPPLY POTENTIAL AND KTDA FACTORY NEED

Source	Potential by Province t/y				Cost Delivered (5)	
	Central	Rift	Eastern	Total	KSh/t	KSh/GJ
Forest Department (1) 8 y model	24 000	5 000	4 000	33 000	321	22.6
Private Tea Estates 4 y model	Very limited				275	19.4
Unused Public Lands 4 y model	11 000	7 000	7 000	25 000	560	39.5
Smallholder 4 y model	84 000	29 000	123 000	236 000	311	21.9
Crop Residues		(2) 140 000	(3) 6 000	146 000	(4) 491/210	(4) 34.6/14.8
Total Supply	119 000	181 000	140 000	440 000		
KTDA Demand	50 000	36 000	14 000	100 000		

Source: Previous tables

Note: (1) Assumes 50% current potential will be available to KTDA.

(2) Unallocated round conifer smallwood of Forest Department. Assume present KTDA delivered cost eucalyptus 291 KSh/t plus transport 100 km @ 2 KSh/tkm = 491 KSh/t. Distances to factories to be confirmed.

(3) Rice husks. Assumed loading 10 KSh/t and 100 km transport @ 2 KSh/tkm.

(4) Small wood/rice husks.

(5) Excludes any profit margin.

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ANNEXURE C2 - MODELS FOR FUELWOOD PRODUCTION

2.1 Forest Department

2.1.1 Eucalyptus Plantations

The Forest Department (1983) carried out a detailed study of costs of growing eucalyptus for fuelwood on an 8 year rotation with two following coppice rotations. The royalty suggested is based on actual costs and 10% discount rates below.

TABLE 2.1 - ROYALTY FOR EUCALYPTUS FUELWOOD TO COVER COST OF PRODUCTION 8 YEAR ROTATION AT 10% DISCOUNT (2)

	1980/81	1981/82	1982/83	1983/84	1984/85		
Royalty (1)	KSh/m^3	KSh/m^3	KSh/m^3	KSh/m^3	KSh/m^3	KSh/t	KSh/GJ
With land rent	60.32	71.36	84.56	95.55	107.49	203.97	14.36
Without land rent	32.11	37.99	45.02	50.87	57.23	108.60	7.65

Source: Forest Department 1983 for prices to 1982/83. Inflated using Study Team data to 1984/85.

Note: (1) Volume m^3(cu.m) is solid.

The sale price in the forest, without land rent, has been derived adding labour costs and net profit as in Annexure C2 Table 2.2 below. This is the price at roadside to which transport and loading costs are added to obtain delivered cost to factory.

(2) Forest Department data does not allow recalculation at 15%

TABLE 2.2 - SALE PRICE AND NET PROFIT FOR EUCALYPTUS FUELWOOD
8 YEAR ROTATION AT 10% DISCOUNT (2)

	Price at Roadside 1980/81	1984/85	Delivered Price Factory (1) 1984/85		
	KSh/m^3	KSh/m^3	KSh/m^3	KSh/t	KSh/GJ
Royalty	32.11	57.23			
Labour Costs	12.08	21.53			
Net Profit	13.18	23.49			
Sale Price	57.37	102.25	118.06	224.02	15.78

Source: Forest Department 1983 for 1980/81 prices.

Note: (1) Assume 10km road transport at 2.0 KSh/tkm plus 10.00 KSh/t for loading.

(2) Forest Department data does not allow recalculation at 15%

2.1.2 Plantations Establishment

An internal Forest Department document (Sept 1985) gave the cost of conifer plantation establishment from 14 stations. Costs were stated to include overheads such as:

- Supervision and administation.
- Maintenance (roads, buildings, water supply)
- Transport
- Protection (fire, patrolling, boundary cleaning, etc)
- Replacement of buildings, vehicles, other equipment

The costs were for a 30 year rotation coniferous timber production plantation but were modified by the Consultant for a 4 year eucalyptus plantation.

TABLE 2.3 - COSTS KSh/ha EUCALYPTUS FUELWOOD PRODUCTION
4 YEAR ROTATION

Year	1	2	3	4
Nursery				
Plant raising	844			
Nursery maintenance	278			
Plantation Establishment				
Land demarcation	78			
Land clearing	238			
Cutting stakes	200			
Staking out	385			
Pitting	461			
Planting	274			
Survey	37			
Beating up	378			
Weeding 1	548	725		
Weeding 2				
Climber cutting			267	-
	3 721	725	267	-

Source: Forest Department

Yield would be 28 cu.m/ha/y for the best sites to 23 cu.m/ha/y for medium quality sites. With adequate fertiliser inputs more than 30 cu.m/ha/y should be a achievable. Annexure C2 Table 2.4 shows the cost of production or royalty for high and medium sites without land rent.

TABLE 2.4 - COST OF FUELWOOD PRODUCTION (ROYALTY ONLY)
4 YEAR ROTATION KSh/m^3 SOLID

Yield	28m^3/ha/y			23m^3/ha/y		
Interest rates	KSh/m^3	KSh/t	KSh/GJ	KSh/m^3	KSh/t	KSh/GJ
0%	42.08	79.85	5.62	51.23	97.21	6.85
8%	56.12	106.50	7.50	68.32	129.64	9.13
10%	60.14	114.12	8.04	73.21	138.92	9.78
15%	71.11	134.93	9.50	86.57	164.27	11.57

Source: Derived from Annexure C2 Table 2.3.

Note: (1) 1m^3 solid = 0.527t 30% mcwb = 14.2 GJ/t.

(2) No fertiliser used.

Using an 8 year rotation at 28m^3/ha/y production costs in Annexure C2
Using an 8 year rotation at 28m /ha/y/ production costs is Annexure C2
Table 2.4 are changed as follows:

- at 10% to 44.04 KSh/m^3, 83.56 KSh/t, 5.89 KSh/GJ
- at 15% to 62.18 KSh/m^3, 117.99 KSh/t, 8.31 KSh/GJ

2.2 Estate A

Data was supplied by Estate A for cost of production for E. saligna fuelwood on an 8 year rotation, and is given below.

TABLE 2.5 - COST OF EUCALYPTUS FUELWOOD PRODUCTION

8 YR ROTATION (KSh/ha) 15% Discount

Item		Years 1	2	3	4	5	6	7	8
Remove trash lining								$56.2m^3$/ha/y solid	
holing, planting, spray								29.6 t/ha/y	
2 times		1 400							
Plants 4400/ha		800							
Weedicide &									
fert. NPK 1 oz. x 4400/ha		200							
Level old trash, put									
in roads		500							
Beating up, spray 2 x		710							
Weedicide & NPK		360							
Spray 1 x slash			460						
1 x weedicide			80						
Spray 1 x slash				330					
	KSh/m^3 stacked basis								
Harvesting									
Fell & split	18.50								13 875
Transport to factory	42.00								31 500
Stack at factory	8.00								6 000
TOTAL		3 970	540	330					51 375

Cost	Royalty	At Roadside	Del. & Stacked
KSh/m^3 solid	31.88	62.71	146.04
KSh/t	60.52	119.02	277.25
KSh/GJ	4.26	8.38	19.53

2.3 Estate B

Data was supplied by Estate B for cost of production for E. saligna fuelwood on an 8 year rotation, and is given below.

TABLE 2.6 - COST OF EUCALYPTUS FUELWOOD PRODUCTION

8 YR ROTATION KSh/ha 15% DISCOUNT)

Item	Year 1	2	3	4	5	6	7	8
Fell & Clear	2 560						$48m^3$/ha/y solid	
Dig & fork	788						25.3 t/ha/y	
Line, hole, plant	1 181							
Weed	656							
Terrace	394							
Roads	500							
Plants 1600/ha	1 000							

KSh/m^3 stacked basis

Harvesting	24.55
Transport	56.30
Stack at factory	3.14

TOTAL	7 079

Cost	Royalty	At Roadside	Del. & Stacked
KSh/m^3 solid	56.39	97.31	196.37
KSh/t	107.00	184.65	372.63
KSh/GJ	7.54	13.01	26.24

2.4 Smallholder Fuelwood Production

Staff of the Beijer Institute in Nairobi advised that the mean volume yield measured on smallholder woodlots was 114 cu.m/ha for eucalyptus. Assuming a 4 year rotation as reasonable for production of poles/fuelwood for sale, this gives about 30 cu.m/ha/y yield in the tea zone with low cost inputs.

The Consultant has made assumptions in producing the cost model in Annexure C2 Table 2.7 by taking his selected fuelwood growing costs from records of two major estates. The costs chosen are almost entirely farmer's labour which has been shadow costed at 60%, a figure assumed by the Consultant after discussion with World Bank Peri-Urban Fuelwood Study Team in Nairobi.

TABLE 2.7 - COST OF FUELWOOD PRODUCTION
4 YRS ROTATION KSh/ha (Smallholder)

Item	Years 1	1 (1)	2	3	4	
						15% interest
Plough of grassland	Full	Shadow				$30m^3$/ha/y solid
5 hrs @ 100 KSh	500	500				15.8t/ha/y
Plants 5000/ha	900	540				
Dig & fork	788	473				
Line, hole plant	1 181	709				
Weed	656	394				
Maintenance	68	41	68/41	68/41	68/41	
TOTAL	4 093	2 656	68/41	68/41	68/41	

Royalty

		Full	Shadow
Cost	KSh/m^3 solid	61.90	34.39
	KSh/t	117.46	78.54
	KSh/GJ	8.27	5.53

Note: (1) Shadow price labour at 60%

68 = full priced labour

41 = shadow priced labour

ANNEXURE C3 - BIOMASS DEMONSTRATION PROJECT

1.0 PROJECT SCOPE

If KTDA proposes to change its tea factories to using biomass as a source of energy for drying, there are a number of questions to be answered, constraints to be overcome and policy matters to be dealt with. The Consultant believes the easiest means to effect the changeover is through a small pilot project which would examine the resource questions in detail and explore the ways of obtaining and growing fuelwood. It would serve to transfer the necessary technology, to KTDA staff and farmers in particular, and help make the social and institutional changes needed to establish KTDA as a viable fuelwood market.

The project scope is outlined as follows:

1.1 Forest Department Resources

- Carry out Forest Department fuelwood plantation inventory.
- Develop management plans for existing plantations, including rehabilitation of substandard plantations.
- Identify other Forest Department sites which may be planted consistent with present government policy of no further clearing of indigenous forests.
- Planning of fuelwood or multi-purpose plantations on sites.
- Inventory Forest Department industrial conifer plantations, especially those from which small roundwood may be underutilised or for which there is no foreseeable market. Confirm opportunities for KTDA fuelwood supply.
- Agree fuelwood and other product allocations from all hardwood plantations and appropriate conifer plantations.
- Agree royalty schedule for fuelwood which reflects the real cost of production, which can be used as a benchmark for general fuelwood pricing in Kenya and which encourages the production of fuelwood as a market crop for the private sector, especially smallholders.

1.2 KTDA Fuelwood Programmes

- Carry out a survey to identify areas of public land which may be used for fuelwood production. Areas will include roadsides, schools and other public buildings, Provincial, District or County Council managed areas, etc.
- Confer with local authorities and develop viable programmes which will involve community participation in costs and benefits.
- Consult with BAT regarding its successful fuelwood programme.

- Plan and commence a pilot programme of say 200 ha for 1986 and 1987 with a final target which could be of the order of 1000 to 2000 ha or more.
- Agree with smallholders on fuelwood prices at stages of on-farm royalty, harvested and delivered.
- Determine market opportunities for specific factories and target dates for supply levels.
- Determine fuelwood species and stem diameters to suit recommended cyclonic combustion technology.
- Develop an extension service to supply good seed and advise farmers on tree growing. Spread the technology of innovative farmers.
- Develop a fuelwood marketing structure which may be along the lines of the present KTDA system for green leaf.
- Decide on a target for fuelwood supply from smallholders which may be say 50 000 t/y coffee rotation. The programme could begin with a pilot phase involving say 5 factories in 1987 and increasing to 10 in 1988 to all 39 by 1989.

1.3 Crop Residues

KTDA should examine the feasibility of using the 6 000 t/y of rice husk available in Embu district. This would require modifications to existing factory combustion systems taking into consideration the high silica content of this biomass.

1.4 Sawdust

KTDA should further investigate the available sawdust potential identified by the Consultants.

2.0 ESTIMATED PROJECT COSTS

The project would assist KTDA in the planning and conversion of all factories to biomass fuel and in the establishment of pilot scale fuelwood production systems. It should establish a number of small plantations along roadsides and on available public lands to act as demonstrations to encourage local involvement and to act as pilot scale technical and social trials. The same kind of programme should be extended to individual farms and both should be supported through an active extension service which would involve direct contact with local communities possibly using an audio-visual unit.

The likely cost of such programmes would be:

		KSh ('000)
. Public lands		
200 ha of demonstration plantings @ 12 500 KSh/ha		2 500
. Smallholders		
1000 farmer demonstration plantings 100 ha @ 5 000 KSh/ha		500
Demonstration nurseries 10 @ 120 000 KSh		1 200
. Audio-Visual Training Unit		
Capital cost of van and equipment		250
. Advisory Services (1)		
Forestry planner/social forester	24 months	15 300
Extension/institutions specialist	24 months	
Other short term	12 months	
. Transport/Equipment		
2 4wd vehicles		750
Other		250
TOTAL ESTIMATED COST		20 750

Note (1) UNDP budget rate $US 15 000/month

ANNEXURE C4 - BIOMASS SPECIES AND PROVENANCES

1.0 Biomass Species in Current Use

Various Eucalyptus species have been introduced to Kenya and several have proven to be highly successful. A primary objective was to produce fuel for the railways, although this was no longer required when diesel-electric engines were substituted for fuelwood fired steam engines. Of the Eucalyptus species introduced, E. saligna was found to be the most suitable for use as fuelwood and village building materials.

The Forest Department has mainly used E. saligna in its hardwood planting programmes along with some Acacias. In the Tea Zone E. saligna has likewise been selected and yields produced have been very high by world standards. More recently one of the private estates has introduced E. grandis, increasing yields in volume, wood weight and net energy.

2.0 Biomass Species for Future Production

2.1 Forest Department Plantation

The main constraint to high wood yield in the Forest Department plantations appears to be management rather than better species selection. However, improvement in yield can be achieved by careful attention to selection, especially of appropriate geographical locations of species called provenances.

The fuelwood production programme should continue with the following basic Eucalyptus species with suggested associated trials. These can be started as part of the proposed KTDA/Forest Department Project as follows.

Tea Zone

Using E. saligna as a standard for comparison, establish trials of:-

- E. grandis - North Queensland and North NSW provenance.
- E. globulus - best provenances from Tasmania.
- Acacia mangium and A. auriculiformis from North Queensland.

While the Acacias are valuable nitrogen producers, their ability to coppice is not high.

Coffee Zone

With lower rainfall, eucalypts from drier parts of Northern Queensland are candidates. E. camaldulensis of Petford provenance is suggested as a basic choice. Trials should include E. tereticornis from Northern Australian provenances and Leucaena leucocephala (Hawaiian giant strains) where soil pH is above 5.5.

2.2 Smallholder Plantations

The smallholder model ideally should use tree species which have the following features:

a. Fast growth
b. Coppicing ability
c. Nitrogen fixing
d. Fodder production from leaves
e. Produce fuelwood and building materials.

Clearly all the features are difficult to find in one species and eucalyptus are difficult to exclude although they do not include features c and d. Some species of Casuarina feature a, c and e but are deficient in b and d. Some legumes are useful candidates, though the Acacias are generally deficient in some features. Species such as Leucaena leucocephala and its close relatives are candidates and may be used as a mixture with, say, eucalyptus, in appropriate spacings, as well as in agroforestry production systems.

Suggested species for smallholders in the Tea Zone are as follows:

E. saligna, E. grandis (North Queensland) E. globulus (best Tasmanian), Casuarina equisetifolia, Leucaena leucocephala (soil over 5.5 pH) Acacia mangium and A. auriculiformis (North Queensland).

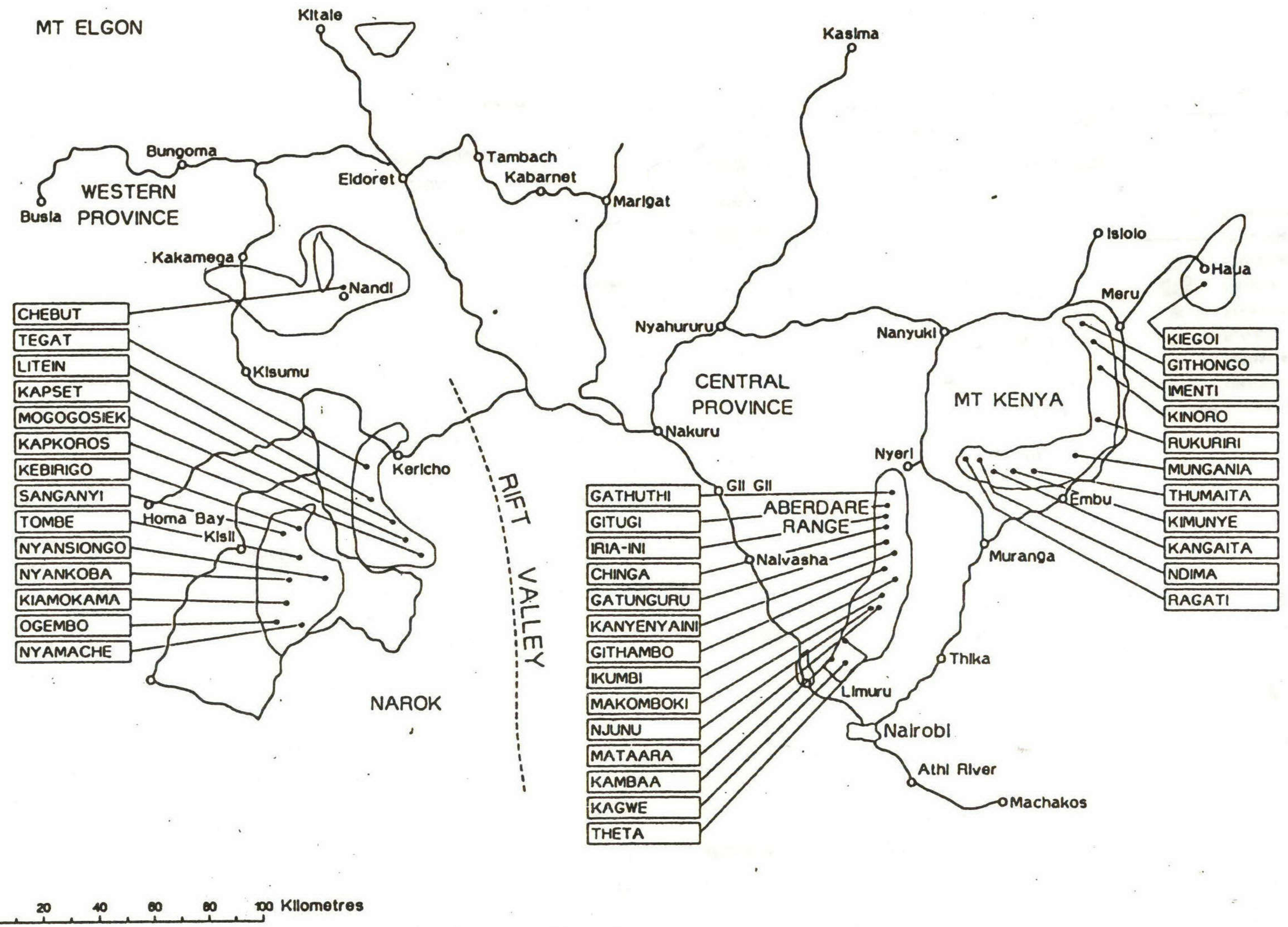
2.3 Research Programme

The KTDA should cooperate with other agencies in developing a research programme to establish the most appropriate species and provenances. These agencies are:

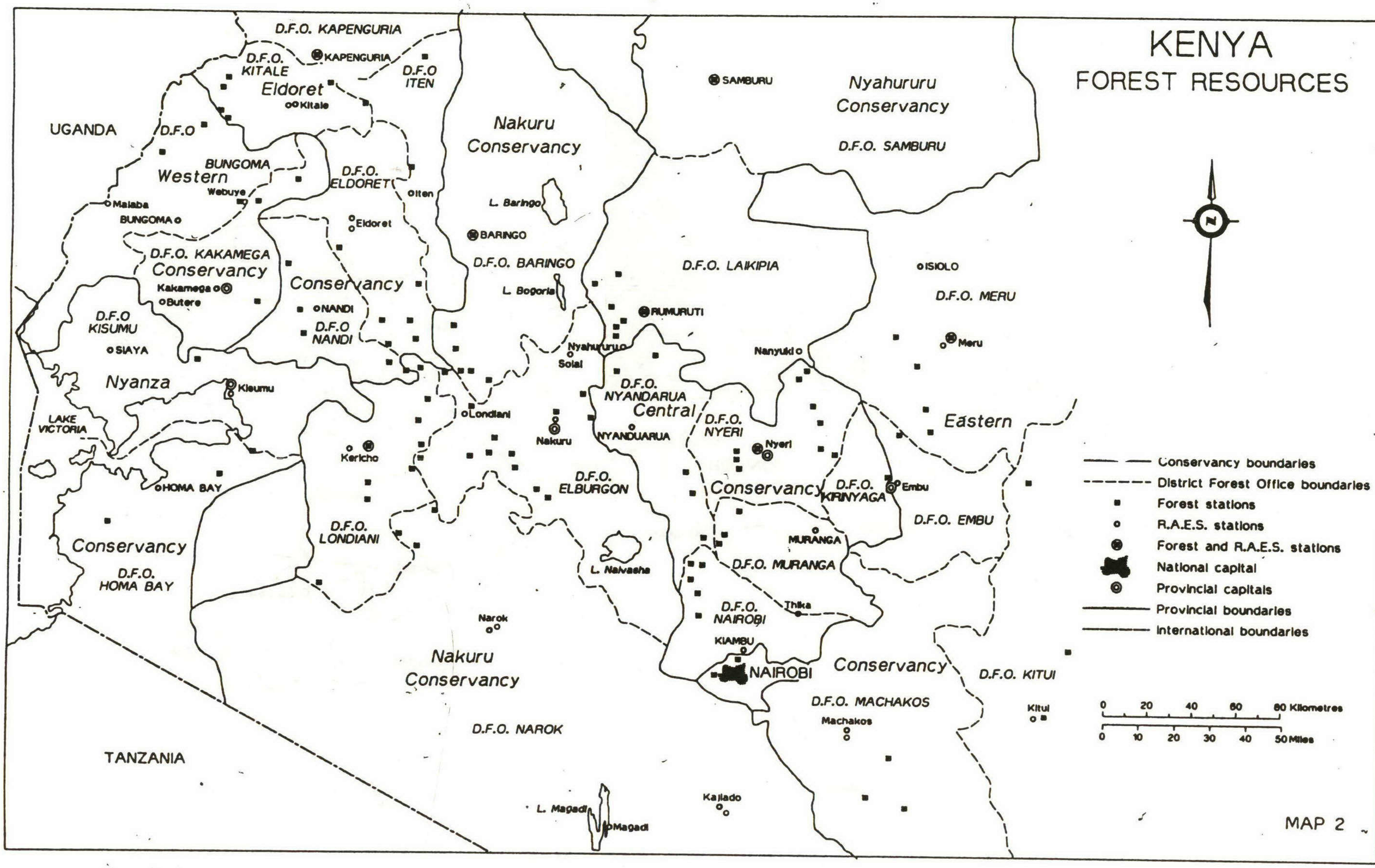
- Forest Department
- International Centre for Research in Agroforestry (ICRAF)
- Australian Centre for International Agricultural Research. (ACIAR)
- Kenya Woodfuel Development Project (Beijer Institute).

KENYA

SMALLHOLDER TEA GROWING AREAS & K.T.D.A FACTORIES



MAP 1



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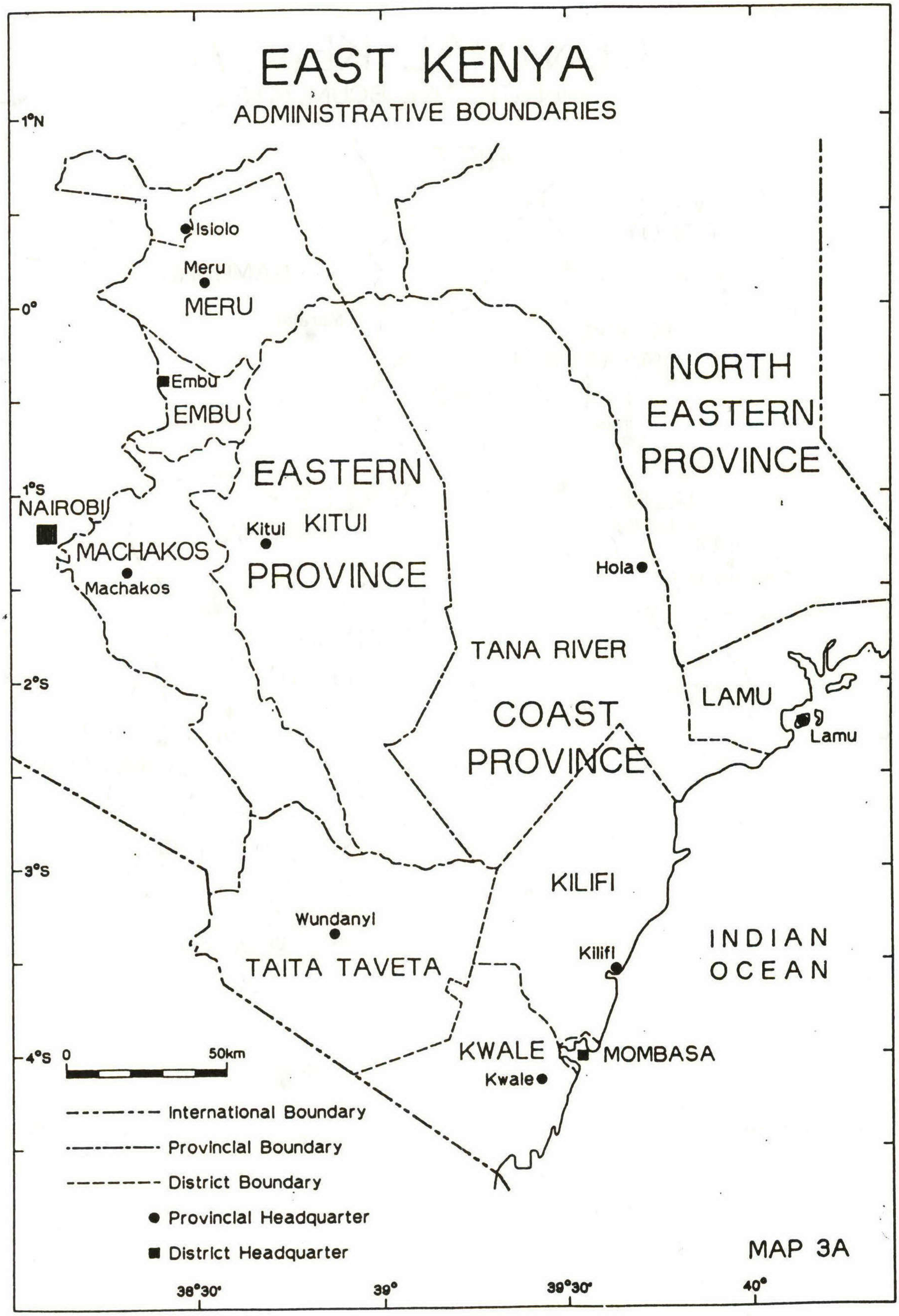
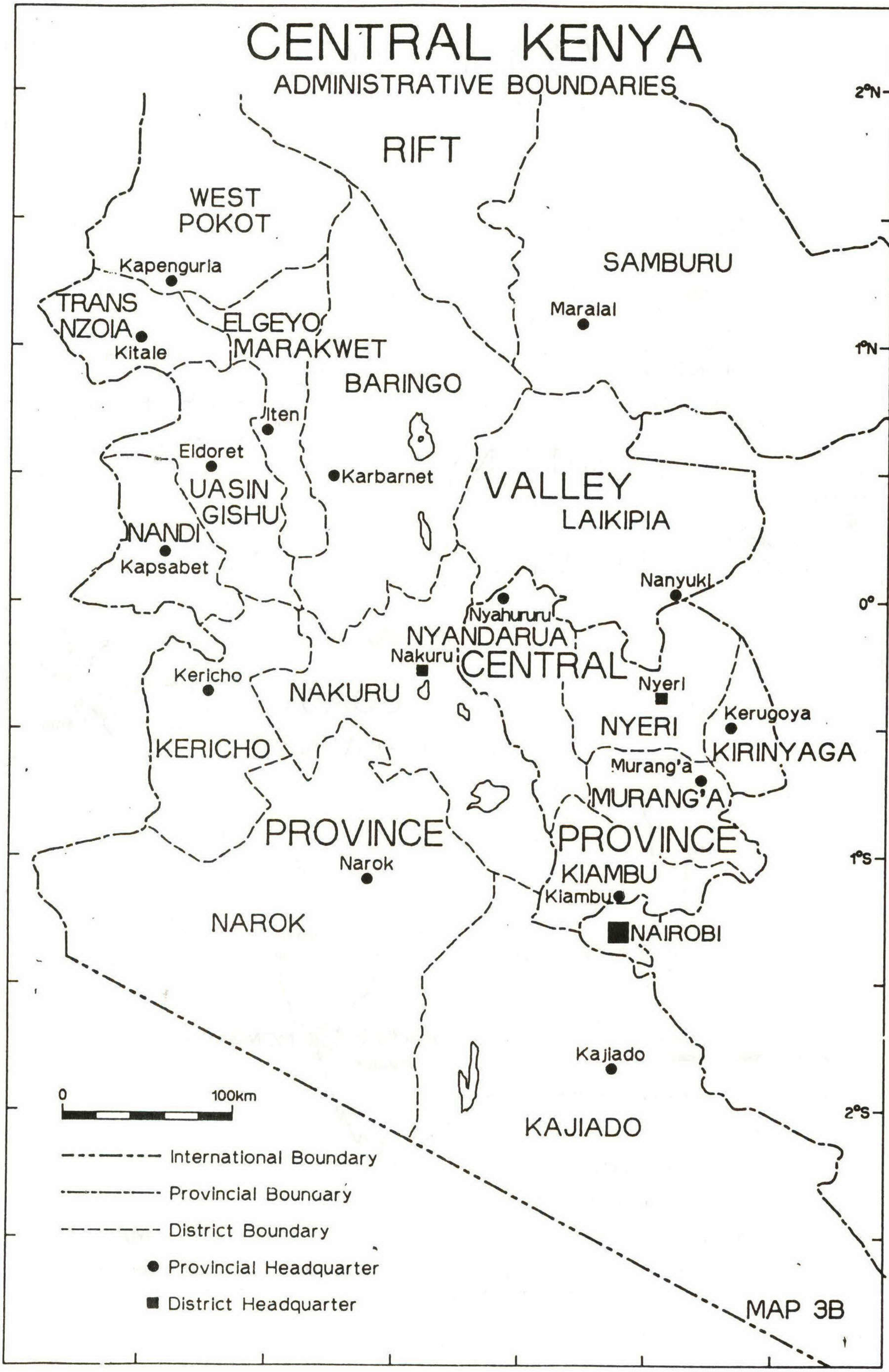
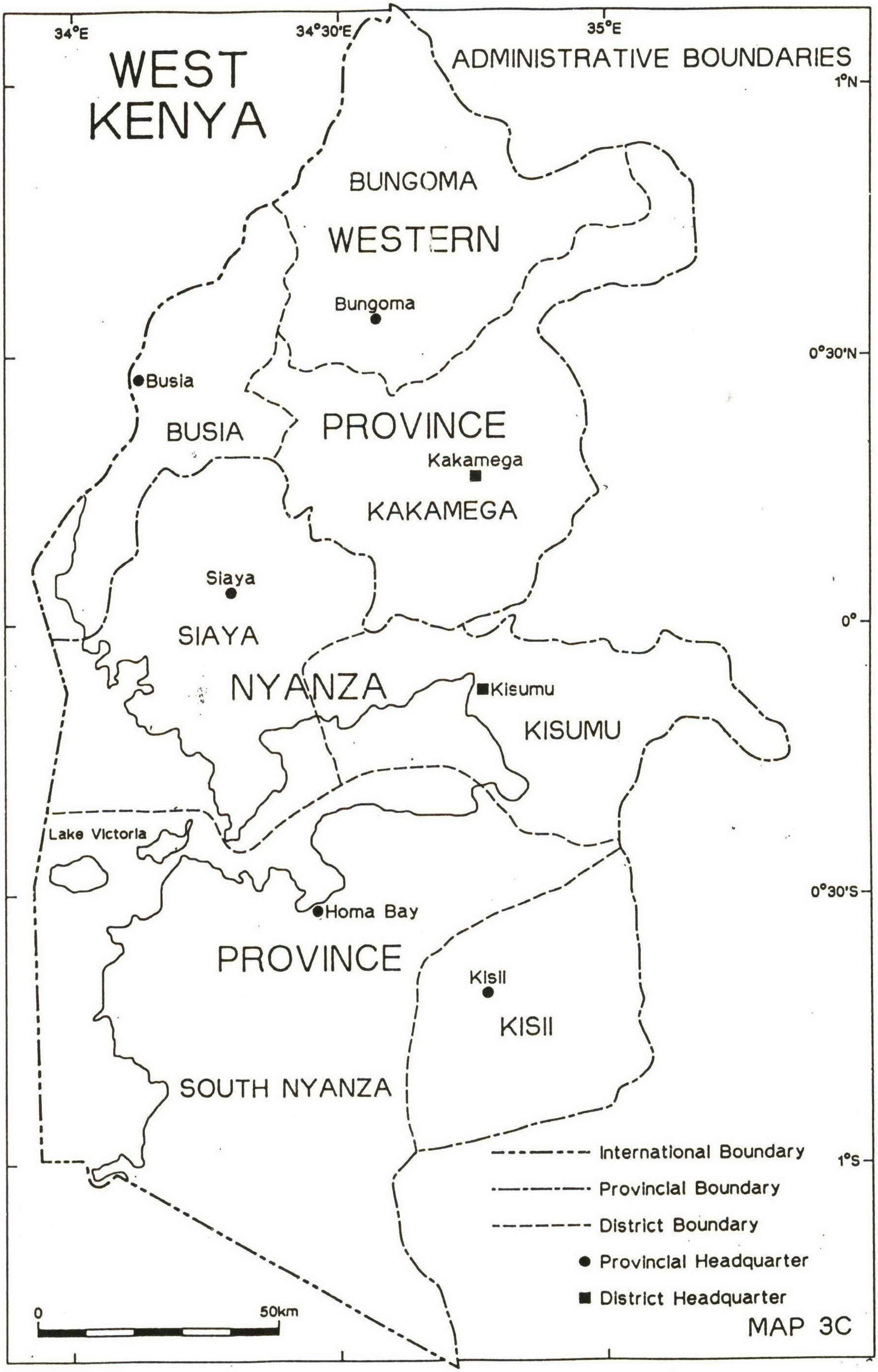
FOREST RESOURCES
UGANDA
TANZANIA
LAKE VICTORIA
D.F.O. KAPENGURIA
KAPENGURIA
D.F.O. KITALE
Eldoret
Kitale
D.F.O ITEN
Iten
D.F.O.
BUNGOMA
Western
Webuye
Malaba
BUNGOMA
D.F.O. ELDORET
Eldoret
D.F.O. KAKAMEGA
Conservancy
Kakamega
Butere
Conservancy
NANDI
D.F.O NANDI
D.F.O KISUMU
SIAYA
Nyanza
Kisumu
HOMA BAY
Conservancy
D.F.O. HOMA BAY
Kericho
D.F.O. LONDIANI
Londiani
Nakuru Conservancy
L. Baringo
BARINGO
D.F.O. BARINGO
L. Bogoria
Nyahururu
Solai
Nakuru
D.F.O. ELBURGON
L. Naivasha
Narok
Nakuru Conservancy
D.F.O. NAROK
L. Magadi
Magadi
SAMBURU
Nyahururu Conservancy
D.F.O. SAMBURU
D.F.O. LAIKIPIA
RUMURUTI
D.F.O. NYANDARUA
Central
NYANDUARUA
D.F.O. NYERI
Nyeri
Nanyuki
Conservancy
D.F.O. KIRINYAGA
Embu
MURANGA
D.F.O. MURANGA
Thika
D.F.O. NAIROBI
KIAMBU
NAIROBI
Conservancy
D.F.O. MACHAKOS
Machakos
Kajiado
ISIOLO
D.F.O. MERU
Meru
Eastern
D.F.O. EMBU
D.F.O. KITUI
Kitui
Conservancy boundaries
District Forest Office boundaries
Forest stations
R.A.E.S. stations
Forest and R.A.E.S. stations
National capital
Provincial capitals
Provincial boundaries
International boundaries
0 20 40 60 80 Kilometres
0 10 20 30 40 50 Miles
MAP 2

C-58


EAST KENYA
ADMINISTRATIVE BOUNDARIES
1°N
0°
1°S
2°S
3°S
4°S
Isiolo
Meru
MERU
Embu
EMBU
NAIROBI
MACHAKOS
Machakos
EASTERN
Kitui
KITUI
PROVINCE
NORTH
EASTERN
PROVINCE
Hola
TANA RIVER
COAST
PROVINCE
LAMU
Lamu
KILIFI
Kilifi
Wundanyi
TAITA TAVETA
INDIAN
OCEAN
KWALE
Kwale
MOMBASA
0
50km
International Boundary
Provincial Boundary
District Boundary
Provincial Headquarter
District Headquarter
MAP 3A
38°30'
39°
39°30'
40°


CENTRAL KENYA
ADMINISTRATIVE BOUNDARIES
RIFT
VALLEY
PROVINCE
WEST POKOT
Kapengurla
TRANS NZOIA
Kitale
ELGEYO MARAKWET
Iten
BARINGO
Karbarnet
SAMBURU
Maralal
UASIN GISHU
Eldoret
NANDI
Kapsabet
LAIKIPIA
Nanyuki
Nyahururu
NYANDARUA
CENTRAL
PROVINCE
Nakuru
NAKURU
Kericho
KERICHO
Nyeri
NYERI
Kerugoya
KIRINYAGA
Murang'a
MURANG'A
KIAMBU
Kiambu
NAIROBI
Narok
NAROK
Kajiado
KAJIADO
2°N
1°N
0°
1°S
2°S
0
100km
International Boundary
Provincial Boundary
District Boundary
Provincial Headquarter
District Headquarter
MAP 3B


WEST KENYA
ADMINISTRATIVE BOUNDARIES
34°E
34°30'E
35°E
1°N
0°30'N
0°
0°30'S
1°S
BUNGOMA
WESTERN
Bungoma
Busia
BUSIA
PROVINCE
Kakamega
KAKAMEGA
Siaya
SIAYA
NYANZA
Kisumu
KISUMU
Lake Victoria
Homa Bay
PROVINCE
Kisii
KISII
SOUTH NYANZA
International Boundary
Provincial Boundary
District Boundary
Provincial Headquarter
District Headquarter
0
50km
MAP 3C

APPENDIX D

SUPPLIES AND PRICES OF FUELS

APPENDIX D - SUPPLIES AND PRICES OF FUELS

1. INTRODUCTION

This Appendix describes the relevant fuels in Kenya and their price ranges fuel prices used to evaluate and test the sensitivity of the investment recommendations made in the study. There are generally three prices used being base, financial and economic.

The base prices were those collected at the individual plants and tea factories audited. The reader should refer to the individual Energy Audit Report for each plant or tea factory to obtain the base price used at that particular plant or factory. local variations were found to be substantial even between enterprises located quite close to each other.

The economic and financial prices are figures developed from observation and analysis and used to assess the project proposals initially selected using the base prices.

This Appendix is largely devoted to the derivation of the financial and economic price ranges. The ranges were first developed before the oil price declines of 1986 but then adjusted during the sensitivity testing to provide a rigorous basis for testing the recommendations.

2. COAL SUPPLIES

Kenya's present coal supplies come from Swaziland at a CIF (cost insurance and freight) Mombasa price of $US 50 per tonne. A duty of 8 percent applied in 1985. This coal has 21 percent ash and 14 percent Volatiles. In subsequent calculations 23.5 GJ/tonne has been used for the gross specific energy of this coal. The coal is unusual because of its low volatile content and this property together with high ash makes it difficult to burn in conventional boilers. It is suitable for cement making but not for boilers.

Swazi reserves are thought to comprise 500 million tonnes which are considered adequate for existing uses but not for substantial substitution for oil. Kenya appears to have taken 85,000 tonnes of the 125,000 tonnes 1984 production from the Mpaka mine. Supplies are prone to interruption by insurgency activities in Mozambique and alternative supplies of similar coals are not readily available from neighbouring countries.

It would not be advisable for Kenya to embark on a major coal substitution programme on the basis of this coal In addition to the possible supply difficulties, boilers would have to be specially designed for it, at extra cost, and would be incapable of burning more readily available substitute coals in the event of an interruption to supply.

Other coals are likely to be substantially more expensive, especially in the relatively small volumes likely to be used in Kenya. Coal in 1985 is available from Australia and other countries at about $US 34 per tonne FOB, but rates for small tonnages are likely to be higher than those paid for Swaziland coal. Available data for deliveries to Europe in July 1985 range from $US 41 to $US 54 per tonne (CIF). It appears that coal for Kenya might be reliably obtained at $US 35 per tonne FOB, plus an allowance of $US 15 per tonne for freight and a $US 5 penalty for Mombasa and small shipment sizes.

The key reasons for the $5 penalty relate to the size of shipment and the unloading facilities likely to be available. Shipment sizes of 20,000 tonnes and less are not attractive to some coal exporters because they occupy facilities designed to load much larger volumes (60,000 to 150,000 tonnes). Small self-unloading vessels are costly to charter and find it difficult to obtain continuous loading unless they are part of a distribution trade.

In 1986 Kenya can expect to pay $US 55 per tonne CIF for thermal coal for annual tonnages of less than 300,000 tonnes. Should annual supply contracts reach 1,000,000 tonnes to be delivered in ships of 40,000 LWT, then rates could fall below $US 55 per tonne CIF Mombasa, possibly reaching $US 50 per tonne.

2.1 Coal Prices in Kenya

Coal is imported to Kenya and in 1985 was subject to import duty at the rate of 8 percent for coal sourced in the Preferential Trade Area (PTA) of Eastern and Southern African countries and 20 percent for other sources. Swaziland coal benefits from the PTA concession.

Coal for use outside the cement industry would' be a coal with higher volatile content than Swaziland coal and is expected to have a price of around $US 55 per tonne CIF Mombasa.

TABLE D.1

CIF PRICES OF COAL AT MOMBASA

($US/t)

Price basis	Swaziland Coal	Thermal Coal
CIF ex duty	50	55
CIF with duty	54	66

Note: CIF stands for Cost, Insurance and Freight.

2.2 Coal Handling

Coal is at present received by Bamburi Portland Cement and handling figures are based on their estimates provided in May 1985. These have been confirmed by observation of handling methods.

TABLE D.2

ESTIMATED HANDLING COSTS FOR COAL

(KSh/t)

	Swaziland	Thermal
Demurrage	32	32
Wharfage 1.5% CIF 1/	13	14 - 18
Insurance, Brokerage, Interest	20	20
Import Licence Fee	16	16
Handling Cost	18	18
Handling Losses (2%)	19	19
Rail Loading	25	25
Total KSh/tonne	143	144 - 148

1/ Converting $US at KSh 17 per $US.

2.3 Transport Costs

Kenya Railways has provided freight rates while road transport costs were collected from the Keyna Transport Association. The results are shown in Table D.3.

TABLE D.3

FREIGHT RATES FROM MOMBASA 1985

(KSh/t)

Destination	Rail Coal	Rail Oil	Road
		KSh/t	
Nairobi	300	355	585
Nakuru	370	460	773
Eldoret	450	543	958
Kisumu	450	540	997
Thika	320	380	634
Athi River	290	326	500

Many of the plants audited receive their oil supplies by road even though rail terminals are available nearby The reason for this appeared to be unreliability of rail delivery. This suggests that the economic costs of delivery of oil or coal by rail are understated if rail freight rates are used.

Similarly, although road freight rates are significantly higher than rail freight, there is evidence from 1981 (1) that road freight charges do not provide for full recovery of the costs of road damage and wear. Subsequently road licence fees have increased and toll charges have been introduced to recover some of the cost of road damage and wear.

For the purposes of calculation, the costs of rail delivered coal were compared with the costs of rail delivered oil and no provision was made for added rail costs to make oil delivery reliable.

2.4 Coal Unloading and Handling into Plant

The cost of coal to a user will depend upon the cost of unloading and handling coal into plant.

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(1) Kampsax International, Study of Road User Charges and Axle Load Limits, Final Report (Nairobi: Government of Kenya, 1981).

Discussions at Bamburi Portland Cement in 1985 indicated that handling coal out of a stockpile into trucks for on shipment is about KSh 10 per tonne (not including transport costs). This estimate is based on KSh 800 per hour including equipment hire and a handling rate of 80 tonnes per hour.

Table D.3 already includes an allowance of KSh 25 per tonne for loading onto rail. A further KSh 25 per tonne is then required for unloading and handling into plant (except Mombasa).

2.5 Coal Costs

The cost of coal delivered by rail into the plants in the various centres can be made up from the previous data. The results are shown in Tables D.4 (KSh/t) and D.5 (KSh/GJ).

TABLE D.4

COAL COSTS DELIVERED INTO PLANT

(KSh/t)

($US = KSh 17.0)

Destination	Swaziland Coal (with duty)	(ex duty)	Thermal Coal ($US55 C.I.F) (with duty)	(ex duty)
Mombasa	1061	993	1266	1079
Nairobi	1386	1318	1591	1404
Nakuru	1456	1388	1661	1474
Eldoret	1536	1468	1741	1554
Kisumu	1536	1468	1741	1554
Magadi	1406	1338	1611	1424
Thika	1406	1338	1611	1424
Athi River	1376	1308	1681	1394

TABLE D.5

COAL COSTS DELIVERED INTO PLANT

(KSh per GJ)

Destination	Swaziland Coal (with duty)	Swaziland Coal (ex duty)	Thermal Coal ($US55 C.I.F) (with duty)	Thermal Coal ($US55 C.I.F) (ex duty)
Mombasa	45.21	42.32	47.24	40.26
Nairobi	59.06	56.17	59.37	52.39
Nakuru	62.05	59.15	61 98	55.00
Eldoret	65.46	62 56	64.96	57.99
Kisumu	65.46	62.56	64.96	57.99
Magadi	59.92	57.02	60.11	53.12
Thika	59.92	57.02	60.11	53.13
Athi River	58.64	55.74	62.72	52.01

Note: Calorific Values

Swaziland Coal	23.46	GJ/tonne
Thermal Coal	26.8	GJ/tonne

2.6 Financial and Economic Costs of Coal

Applying exchange rate and labour cost adjustments to each of the coal delivery steps enables the calculation of economic costs. Table D.6 shows the subdivision of costs into foreign and local components and the resulting financial (or market) prices and economic costs.

2.7 Forecast Coal Prices

Future prices of coal are forecast to remain fixed at current levels in real terms.

TABLE D.6

KENYA: FINANCIAL AND ECONOMIC PRICES OF COAL 1985 (KSh/tonne)

(DELIVERED NAIROBI)

	Swaziland (23 5 GJ/t)		Thermal* (26.8 GJ/t)		Financial		Economic	
	Foreign	Local	Foreign	Local	Swazi	Thermal	Swazi	Thermal
F.O.B. Port of Origin	510	-	595	-	510	595	612	714
Shipping	255	85	340	-	340	340	391	408
Duty	-	68	-	187	68	187	-	-
C.I.F.								
SUB KSh/t	765	153	935	187	918	1122	1003	1122
TOTAL KSh/t	32.60	6.52	34.89	6.98	39.12	41.87	42.74	41.87
Demurrage	24	8	32		32	32	37	38
Wharfage 1.5% CIF	6	7	4	10	13	14	14	15
Insurance, Interest	20		20		20	20	24	24
Export Licence		16		16	16	16	16	16
Handling		18		18	18	18	9	9
Losses	19		19		19	19	23	23
Rail loading	20	5	20	5	25	25	29	29
Freight NBI	240	60	240	60	300	300	348	348
Rail Unloading	20	5	20	5	25	25	29	29
KSh/t	1114	272	1290	301	1386	1591	1532	1653
TOTAL KSh/GJ	47.47	11.59	48.13	11.33	59.06	59.37	65.29	61.68

Sources: See text. Shadow prices as below:

	Financial	Economic
Exchange Rate	17 KSh/$	20.4 KSh/$
Labour (urban)	100%	50%

* Thermal coal is assumed available at $35/tonne F 0 B. port of origin and shipping charges are set at $20/tonne

3. REFINED OIL PRODUCTS

Kenya can obtain refined oil products by direct import or through the Kenya Petroleum Refineries Ltd refinery at Mombasa. To safeguard the interest of the refinery it is the government policy to discourage imports of refined product; while surplus refined product, mainly fuel oil of a generally lower quality than used in Kenyan industry, is re-exported into spot markets.

3.1 Current Prices

Prices of refined product in Kenya differ from the cost of imported refined product. The pricing of refined product recovers the total cost of the crude, refinery fees and transport and handling charges up country. Allocation of these costs between individual refined products is affected by demand and policy factors.

Refinery charges in Kenya average $US 15.5 to 16.0 per tonne of crude. Using an actual refinery out turn, it is possible to derive the effective cost of crude and the total cost of refinery derived fuels. The actual price of crude CIF Mombasa was estimated to have fallen from $US 228/tonne in 1983 to $US 207/tonne in mid 1985.

The 1985 domestic prices of refined product are shown in Table D.7 in a form comparable with the CIF prices of imported refined product. These estimates are from the World Bank and appear to reflect contract prices in the Middle East. The Table also shows the estimated price of exported fuel oil FOB Mombasa obtained in discussion with MOERD.

In addition, this Table shows prices charged in-bond for various refined products in Kenya. These provide the basis for financial prices of residual fuel oil in Kenya.

There are two possible bases which could be considered for the economic pricing of fuel oil in Kenya, namely either the import parity price (being based on the CIF Mombasa price of imported refined fuel oil) or the export price FOB Mombasa of exported surplus refined fuel oil, adjusted for transport costs The Consultants have considered both approaches and believe the FOB Mombasa determined price to be the appropriate basis since the question of refinery policy lies outside the scope of this study and because it reflects the actual economic circumstances facing Kenya.

TABLE D.7

REFINED PRODUCT PRICES IN KENYA, 1985

Product	In Bond Price			Import Price CIF Mombasa	Export Price FOB Mombasa
	KSh per '000 litres	KSh per tonne	$US per tonne	$US per tonne	
LPG	n.a.	5781.90	340.11		
Premium	4666.60	6427.82	378.11	336.82	
Regular	4487.60	6181.27	363.60		
Kerosene	3510.60	4281.22	251.84	296.14	
AGO*	3821.40	4620.80	271.81	265 88	
Jet Kero	4722.78	5759.49	338.79		
Marine G.O.*	4248.00	5136.64	302.16		
IDO	3415.00	4065.48	239.15		
FO 125CST	2255.00	2401.49	141.26	192.83	125.00
FO 180CST	2181.00	2322.68	136 63		
FO 280CST	1886.00	2008.52	118.15		

Converted to $US 1 = KSh 17
* Density assumed identical

Source: Ministry of Energy and Regional Development (Annex 1), and World Bank

The adoption of low prices for fuel oil in Kenya reflects the situation in which fuel oil, as a surplus product from refining in Kenya, must be exported and receive low prices. The product which is re-exported is heavy grade fuel oil; the lighter grades fuel oil are sold in Kenya and in neighbouring countries, with some sales being made in spot markets by each marketer, and the product shipped from Kenya. Some fuel oil is sold as feedstock for refineries in other countries which can crack it to lighter fractions.

In 1985 the price received for exports of fuel oil from Kenya approximate $US 135 per tonne (FOB destination), from which shipping costs of $US 10 per tonne needed to be deducted. Contract prices were at the time above spot prices and marketers with contract sales were able to sell fuel oil and dual purpose kerosene overseas at higher prices than in Kenya. By 1986 the FOB Mombasa price had fallen to US$41-50 per tonne.

3.2 Oil Transport

There are differences in transport costs to different parts of Kenya. Table D.8 gives the transport differentials needed for calculating fuel oil prices outside Nairobi using the delivery charge basis discussed under Oil Products in Section 6.1.

TABLE D.8

OIL TRANSPORT DIFFERENTIALS (KSh/GJ)

Location	Financial	Economic
	KSh/GJ	
Nairobi	0	0
Mombasa	-8.29	-9.62
Nakuru	2.44	2.83
Eldoret	4.39	5.09
Kisumu	4.39	5.09
Magadi	0.65	0.75
Thika	0.65	0.75
Athi River	-0.65	-0.75

Source: See text.

3.3 Price Forecasts for Refined Products

Over the period to 1995 there are expectations of possible short term lower crude oil prices, perhaps allowing fuel oil to fall relative to coal, (although any such move is not expected to result in lower coal prices). The combination of growing non OPEC oil supply with a short term fall and then a slow growth in demand, yields a forecast of a drop in oil prices followed by recovery to about 1985 levels by 1995.

As this report was being finalised, spot prices for crude oil had fallen well below $US 20 per barrel to around $US 12-15. The level to which prices fall and the duration of low prices are the subject of conjecture and will depend upon the willingness of high cost oil producers to continue to discover, develop, store and deliver oil at low prices; and on the demand for oil at low prices. Meanwhile consumers in Kenya will not obtain all of the benefit of falling oil prices because there will be a need to increase refining margins. Nevertheless, lower crude oil prices will reduce the oil import burden, freeing foreign exchange for other needed imports and reducing the pre-tax cost of refined products.

The future patterns of fuel oil prices in relation to crude price will depend upon the match between world refinery capacity to upgrade residual products, coal prices and demand. World demand for residual fuel oil, apart from refinery feedstock, has been relatively constant as coal and natural gas substitutes and improving energy efficiency all have had their effect. Progressively smaller shares of crude have been saleable as fuel oil and so more and more has been refined to lighter product 1/. In general, fuel oil is expected to remain constant in relation to crude in order to meet growing competition from coal, the prices of which are expected to remain constant in real terms. Gasoline, kerosene and gas oil prices are forecast to rise in relation to crude oil by 1990 as refiners attempt to recover margins lost while crude oil rose and demand slackened 2/.

Table D.9 reproduces these forecasts. World Bank 1985 forecasts were for declining crude prices recovering to current levels by 1995. The Bank's revisions to its forecasts after the oil price fall in 1986 indicated 1995 figures some 25% - 30% lower However there is a diversity of views about future oil prices. In this report, therefore, the forecasts have been left as computed in 1985 while, for the purpose of evaluation, the sensitivity analyses described in Chapter 8 and this Appendix have been designed to allow the introduction of other prices if preferred. In the longer term, against which investment decisions will need to be based, the Consultants expect oil prices to recover substantially from the 1986 levels.

Prices for liquefied petroleum gas are not quoted in reports to hand This product is capable of being imported in the quantities in which it is used in Kenya, but at a cost penalty which relates to its volatile nature. It is forecast to vary with crude but to fall less rapidly between 1985 and 1990.

1/ T.R. Breton "Further Declines in World Demand" Petroleum Economist, June 1984.

2/ The Economist, 197: 7415, (October 12, 1985) p.15.

TABLE D.9

RECENT AND FORECAST CIF IMPORT PRICES MOMBASA
FOR REFINED AND CRUDE OIL PRODUCTS ($US per tonne)

Year	Crude	Gasoline	Kerosene	Gas Oil	Fuel Oil	LPG
1982	250.88	394.60	395.16	352.95	206.50	
1983	227.75	382.57	379.19	338.02	203.80	
1984	211.19	343.70	299.11	274.86	192.80	
1985	207.29	336.82	296.14	265.88	192.83	399.94*
			Forecast (1985 dollars)			
1990	175	300	285	255	155	345
1995	210	360	340	200	405	

Source: See text

* LPG calculated as 135 percent of kerosene price for 1985.

4. FUELWOOD

Future prices of fuelwood in Kenya are an important input to choice of alternative fuels, especially indigenous fuels. The principal issue is future wood price relative to future fuel oil price. The key point about future fuelwood prices is the complete uncertainty as to what they will be.

Fuelwood supplies come from many sources and the market is at present well supplied. Current financial prices are low (KSh 250 per tonne maximum) compared with the proper economic cost and fuelwood users, with few exceptions, report little difficulty obtaining supply. Major sources include land clearance operations, forestry operations, commercial woodlots (which often are committed to particular use), and individual farms.

Land clearance operations supply wood for charcoal making and are a major source. There is also emerging commercial and community activity in forest plantations. However, wood from plantations will be inherently more costly than wood from land clearance which is likely to continue for some time driven by rapid population growth. Plantations have to recover capitalised costs of planting, tending and holding land as well as costs of felling.

Foresters and environmentalists worry that when land clearance supplies of wood fall away, there will be insufficient forest yield to cope with demand. This tends to ignore the effect on forest investment of an expectation of rising wood prices. The projections of future shortages are widely understood and at least some investment in new forest resource is now taking place in expectation of future higher prices.

The upper limit for future prices of fuelwood would occur if all supply were to come from fuelwood plantation cropping. This point seems cost unlikely to be reached, however, because land clearance and agro forestry activities can be expected to continue, and these sources should always be lower cost, at site, than monocultural plantation forestry. This is because clearance and agro-forestry recover some costs from sales of cleared land and produce as well as wood.

4.1 Previous Studies

The main information on this subject drives from the ongoing Peri-Urban Fuelwood Study and a series of studies by the Beijer Institute 1/. Most results are reported in Sections 2.3 and 2.4 of Appendix E with others in Appendix C of the report on the companion study Energy Efficiency in the Tea Industry Early results of the Peri-Urban Fuelwood Study were available for review by the Consultants.

4.1.1 Methodology

Previous studies, and particularly the Peri-Urban Fuelwood Study, place emphasis on the foreign exchange cost of alternative fuels, especially kerosene, and use discount rates of 10 percent which is low. They also shadow price labour in rural areas where labour is scarce.

The Consultants have modified the results of the Peri-Urban Study to allow for 15 percent discount rate and to reduce the shadow pricing of scarce rural labour. Different land costs have also been considered. The view formed is that the economic price of fuelwood could be as high as KSh 650/tonne or about 45 KSh/GJ.

4.1.2 Fuelwood Transport

Fuelwood which is low cost on the stump can rapidly become high cost once removed far from forested zones.

1/ See especially Keith Openshaw, ,Costs and Benefits of Proposed Tree Planting Programme for Satisfying Kenya Wood Energy Requirements, Part II, Appendices, Nairobi: The Beijer Institute, (1982); Fuelwood Policy Programme Cost Estimates, A Supplement to Energy Development in Kenya: Problems and Opportunities, Nairobi: The Beijer Institute, February 1982, and Richard Hosier, "Social Cost Benefit Analysis of Fuelwood Development Projects" Nairobi' The Beijer Institute, April 1982.

Table D.10 provides the basis for costing the transport of fuelwood taking into account fuelwood bulk density and freight rates noted in Kenya in 1985. It should, however, be noted that, from observations of fuelwood supply, it is anticipated that an appropriate selection of wood species will be able to be grown near the industrial sites or tea factories.

4.1.3 Re-estimates for Fuelwood

The calculation procedure used by the Peri-Urban Fuelwood Study estimates the year by year costs of the plantation and the cubic metre yields obtained. Both yields and costs are discounted to the start year. The cost unit is obtained by dividing the discounted cost by the discounted yield. Delivery costs would add between KSh 75 and KSh 100 per cubic metre to these costs.

In general the future financial cost of wood, excluding land costs, could be in the range of KSh 150 to KSh 350 per cubic metre which is equivalent to around 20 - 47 KSh/GJ. If land costs are added, costs could rise by a further KSh 300 to reach KSh 450 600 per cubic metre, or 60 - 87 KSh/GJ.

The actual figures will be strongly influenced by any supply/demand imbalance; and the Consultants found no sound reasons why fuelwood could not reach or exceed fuel oil prices if the shortages being claimed for this market were to materialise.

4.2 Economic and Financial Prices of Fuelwood

The future path of fuelwood prices is subject to great uncertainty. Field investigations by the Consultants indicated that industrial users were having no difficulty obtaining fuelwood at very low prices. However, some evidence points to widespread clearance of forest and a future shortage at current market prices. Moreover, increase demand due to rapid urban growth plus fuelwood substitution for oil seems likely to encourage a commercialised fuelwood market with much higher prices which would stimulate private supply from yield as well as stock. It would also extend the area of accessible fuelwood stock as higher prices recover the cost of longer transport distances and of access to more remote forested areas.

Based on the economic costs of producing short rotation fuelwood with land preparation by share croppers, plantation cost could be KSh 400 per tonne of fuelwood and land costs could add KSh 100 per tonne. Fuelwood so produced would have an assumed Gross Specific energy of 14.2 GJ per tonne and need to be transported to plant. With up to KSh 300/tonne allowed for transport over some distance the economic price could total near KSh 800/per tonne of 56 KSh/GJ.

Various studies have indicated economic prices of fuelwood ranging as high as KSh 600/tonne delivered while low estimates from the Peri-Urban Fuelwood Study are as little as 4 KSh/GJ on the stump. The range of prices selected for analysis in this study provides for the transport and handling of the fuelwood and has been largely based on the prices reported by the Peri-Urban Fuelwood Study.

At present a commercial market for fuelwood is not fully established as it is for charcoal and comprehensive data on fuelwood prices are not available. Nevertheless the Consultants believe it likely that financial prices will rise towards economic cost as the fuelwood becomes commercialised, possibly over a ten year horison.

The range of financial prices of fuelwood includes at the low end, the average of observed costs obtained at audited plants and tea factories. This average of 18.31 KSh/GJ was seen to be affected by the sales of wood from Government forests. However, studies by the Peri-Urban Fuelwood Group have shown that these sales do not recover the costs of growing the timber so that future supplies from this source can be considered unreliable.

The results in Table D.11 suggest that looking ahead a similar period the financial price of fuelwood, delivered, could reach 64 KSh/GJ compared with thermal coal 69 KSh/GJ and fuel oil of around 60 KSh/GJ also, depending on grade.

This outcome is dependent upon several issues, including:

- the rate of emergence of plantation supplies and from agro-forestry compared with lower cost supplies from land clearance;
- the extent of commercialisation of the fuelwood market. At present, fuelwood supply is not significantly commercialised and prices are low;
- the rate of emergence of industrial demand for fuelwood in the commercial market. Where supplies can be obtained off market, particularly where land can be obtained at no cost, then supplies will be much cheaper.

5. ELECTRICITY TARIFFS

The electricity supply authority in Kenya is Kenya Power and Lighting Company Limited (KPLC) under the Ministry of Energy and Regional Development.

According to discussion with KPLC, tariffs are based on long run marginal costs calculated from 5 year capital investment plans and demand projections. However recent tariff increases have had more to do with changes in the exchange rate relative to the currencies in which debts are denominated and the effect of this on capital and interest repayments.

Demand for electricity has not been sensitive to tariff but has been sensitive to industrial output. KPLC has forecast growth of total electrical energy demand to be 2 percent faster than the growth of Gross Domestic Product (GDP). Industrial electrical energy demand is forecast to grow at the same rate as GDP. These forecasts suggest a 6 percent per annum growth in electrical energy demand.

The Power System Efficiency Report dated March 1984, prepared jointly by UNDP and World Bank under ESMAP, discusses long run marginal costs The existing system as dominated by hydroelectric and geothermal capacity. Power is also imported from Uganda. System capacity is therefore partly dependent on rainfall and the limited thermal capacity is intended to be used only when rainfall is inadequate.

Existing thermal capacity is dilapidated and unreliable. In May 1985 following a visit to Kipevu Power Station it was estimated that of a name plate capacity of 114 MW the current capability was 13 MW. Routine maintenance was expected to return 39MW to service and a further 45 MW would require at least 4 months and long term maintenance or replacement. The Kipevu Power Station is unsuited by site and location to any coal conversion.

A study to produce a Master Power Development Plan was commenced in February 1986, after the field work for this study ended.

KPLC gives the following typical electricity generating capacity costs in dollars per kilowatt installed for mid 1983-

Generator Type	$US per kw Capacity
Hydro - Kiambere	1800
Turkwell Gorge	1800 - 2200
Other	2500 - 5000
Geothermal	1800 - 2200
Coal Thermal	1200 - 1300
Oil Thermal	800 - 900
Diesel	700 - 800
Gas Turbine	400 - 500

Generation costs for the various types of generators are given in Appendix G as follows:

Type	cents/kwh	$US/GJ
Hydro electric	4	11.1
Geotechnical	4	11.1
Thermal (Fuel Oil)	3	8.3
Thermal (Coal)	5	13.9

In the period to 1987-90, when Kiambere hydro electric power station is expected to come on stream, KPLC expects to have an electrical energy shortage which will partly be made up from thermal sources. The financial burden should also remain constant once Kiambere is in place and this should result in tariffs remaining constant in real terms for a few years after 1988.

The financial and economic prices used in this report are derived respectively from observed costs of audited plants and from other hydroelectric project evaluations. These figures are presented in Table D.11. The economic prices of electricity reflect the use of thermal plant to supply during periods of hydro energy shortage. The costs of new capacity will rise and have a large component of foreign exchange.

6. SUMMARY OF ECONOMIC AND FINANCIAL PRICES OF FUELS

6.1. General

Table D.11 gives the financial and economic prices assumed for relevant fuels. For ease of comparison results are given in KSh per GJ together with the assumed gross specific energy values.

The concept of economic price is intended to reflect the opportunity cost to Kenya of using a particular material as fuel. The value is estimated as a border cost for internationally traded commodities, that is the cost to import the commodity. For untraded and domestically produced goods, the economic price is an estimate of the resources required to replace the good in its next most valued use or the value foregone in not having the resource available for that use. Values of untraded fuels are given at source. Allowance for delivery into plant will vary, being particularly significant for fuelwood.

A summary of the economic and price assumptions adopted for each relevant fuel is given in Table D.10 which describes the main features of cost, excluding foreign exchange and labour, which are used in estimating the values in Table D.11.

Coal: All coal prices and delivery costs are derived from table D.6.

Oil Products: The economic price of oil products in Kenya is the F.O.B. price of conserved oil re-exported, plus the current average cost of transport to the KTDA factories. Loading charges at Mombasa are ignored because that are small. Following recent fluctuations the F.O.B. price of fuel oil exported from Mombasa averaged 25 KSh/GJ between July 1985 and June 1986. Financial prices are based on the average of prices observed at plants (71.5 KSh/GJ) less delivery costs estimated as follows. Financial delivery charges are derived from Annex 1 taking account of pipeline and town delivery fees and adjusting for the exchange rate (17 KSh per dollar), density (in tonnes per 1000 litres) and Gross Specific Energy. The Economic delivery charge is derived from the market rate by adjusting for the foreign exchange component as given in Table D.10. For all transport the import component is assumed to be is 80 percent of cost and the import component is given a premium of 20 percent. This means that for all oil products the economic delivery charge is 16 percent above the financial delivery charge. These amounts are small and special conversion of pipeline costs was not considered warranted.

Fuelwood: Table D.10 and Section 4 give the basis of the economic fuelwood prices. Financial and economic delivery costs are also described with delivery being discussed further in Section 6.2.2. As noted earlier, it is expected that fuelwood, in line with practice observed during the audits, will be obtained from nearby sources, often grown for the purpose. Under these circumstances the range of economic and financial prices for fuelwood, given in table D.10, is sufficiently wide for locational differences to be covered.

In Nairobi the low range of fuelwood prices would not be expected to obtain because of high land costs. Elsewhere the ranges provide sufficient guidance for prefeasibility evaluations.

Sawdust and Byproduct: The economic and financial prices of sawdust and byproduct are taken to be identical with the derivation given in Table D.10 based on discussion in Appendix E.

Electricity: The economic price of electricity is based on results derived for the recent relevant hydroelectric studies The financial price of electricity is taken from the energy charges in the published 1985 tariff for 11000 volt supplies. Tariff details are provided in each audit report. Also used in setting this range are average electricity costs observed at audited plants. A high estimate is derived from the case in which energy demand management leads to rising tariffs during the planning period. The Consultants understand that energy supply difficulties could be experienced in the next few years until new capacity comes on stream.

Since the need is only to establish range values for the sensitivity tests no distinction is made between demand and energy charges in these electricity tariff forecasts. The evaluation of each proposed investment has been based on the demand and energy tariffs applying at that plant in 1984 or 1985 with the evaluations taking account of load factor.

TABLE D.10

SUMMARY OF ECONOMIC PRICING ASSUMPTIONS

Fuel	Basis of Economic Price	Foreign Exchange Economic Cost	Basis of Delivery Cost into Plant	Foreign Exchange in Delivery Cost
Fuel Oil	Export earnings on displaced consumption	100%	Rail Delivery	80%
Electricity	Turkwell Gorge Study	80%	n.a.	n.a.
Fuelwood	KSh 400/tonne plantation cost plus KSh 100/ tonne land cost and Peri-Urban Fuelwood Study	15%	100 km round trip 2.5 tonne in 7 tonne truck. KSh 1.4 per tonne km	70%
Sawdust	Price to sawmill KSh 100/tonne	0	100 km round trip 7 tonne truck delivers 4 cu metres in container. KSh 1 4 per tonne km Density 738 kg/m3	70%
Coal	C.I.F. price Mombasa	100%	Rail Delivery	80%
Grain Byproduct	As sawdust KSh 100/tonne	0	As for fuelwood	70%

Source: See text.

	Market	Economic	
Exchange rate adjustment	17	20.4	KSh/$
Labour	100	50	percent

TABLE D.11

KENYA: FORECAST ECONOMIC AND FINANCIAL PRICES OF FUELS

(KSh/GJ)

Fuel	Gross Specific Energy GJ/tonne	Economic Price	Financial Price	Delivery Charge to KTDA Factories	
Imported Fuels		C.I.F. Mombasa	C.I.F. Mombasa	Economic	Financial
RFO 280 CST	42.9	25	53	21	19
Thermal Coal	26.8	42	42	20*	18*
			* To Nairobi Only		
Untraded Fuels		At mill or edge of forest	At mill or edge of forest		Delivery 50kms
Fuelwood (30%) mcbw	14.2	36	36	32	28
Sawdust (50%) mcbw	10.2	10	10	37	33
Grain By-product	13.9	7	7	27	24
Electricity	n.a	392	164	n.a.	n.a.

Source: See text and biomass discussion

Note: Economic cost is border price or opportunity cost. Financial price includes duties and charges. This table includes foreign exchange cost adjustment. Delivery charges for Untraded Fuels can be pro-rated for different distances.

7. SENSITIVITY TESTING

7.1 Introduction

It was anticipated at the outset of the programme that the justification for any nominated projects would depend upon the level of fuel savings resulting from their proposed investments, and hence would be sensitive to changes in fuel prices. It was further recognised that the 1986 prices of oil, fuelwood and other energy sources were not a sufficient basis to use in judging projects. In order to ensure the soundness of any recommended investments it was therefore envisaged that sensitivity testing would be completed for an appropriate range of prices.

The Consultants forecast fuel prices to rise. Indeed, as noted in this Appendix the main forecasts completed in 1985 anticipated fuel oil returning to the same 1985 prices in real terms by 1995. With the collapse of oil prices in 1986 others (including the World Bank) developed more conservative expectations of oil's future, suggesting 1995 prices down some 25% - 30% on those figures although still well up on 1986 levels. It is an area of considerable uncertainty with it becoming apparent that the investment decisions, when they are made, could well face a very different range of energy prices.

For these reasons a sensitivity analysis approach was designed and used to clarify the viability of the various projects and at the same time provide a basis for assessing their priorities in the light of preferred price scenarios for the various fuels.

7.2 Evaluation Procedure

All projects identified as prospective opportunities during the Consultants' fieldwork were subjected to a full financial analysis as a basis for checking their relative importance. This involved scheduling all relevant costs and benefits over the ten year time horizon and then the computating the internal rates of return, net present values at a 15% discount rate and simple pay-back periods for all projects. From this evaluation, those which continued to look promising were then grouped into categories of like characteristics.

The projects from each of these categories were then evaluated using three different economic frameworks. These covered respectively an equity financed cash flow, a debt financed cash flow and a foreign debt financed economic evaluation.

Equity financed cash flow debited the full capital cost of the project at the time of investment. The estimated fuel cost savings were credited after tax, together with depreciation tax benefits.

Debt financed cash flow debited half the capital cost of the project, at the time of investment, with eight equal annual debt repayments for half the capital cost starting from the second year after investment. The estimated fuel cost savings were credited after interest and tax, together with depreciation tax benefits.

Foreign debt financed economic evaluation debited the project with its full capital cost at the time of investment and applied a foreign exchange loading to the imported components. A credit and foreign exchange premium was provided for foreign debt drawdown of half the capital cost and debt repayment and interest were debited with a foreign exchange premium as they were paid. Interest was assumed to begin immediately and debt repayment after a two year lag. Total savings of fuel were credited to the project.

In addition, for each project using sets of fuel prices the breakeven price relationship was established for the principal fuel(s) involved i.e. establishing the relative prices of which a zero value for NPV for that project would be obtained.

Where two fuels were involved (such as fuelwood substituting for fuel oil) the breakeven relationship between the two was presented in the form:

Breakeven price of Fuel 1 = Constant + Coefficient x Expected price of Fuel 2

(where the breakeven price results in NPV=0)

This relationship provided a continuous basis for sensitivity testing, known as 'crossover analysis', enabling the viability of the project to be assessed at any nominated forecast prices for the fuels concerned. The Consultants subjected these results for all of the projects to sensitivity analyses - again computing the breakeven relationships, confirming that these closely matched the economic case, and then assessing each project's viability in the light of forecast prices for the fuels.

From this process it was possible to identify which projects strongly justified investment, which would be unrealistic to implement, and which were marginal cases that could require more detailed analysis to determine their suitability.

In all instances the analysis was checked to see that the economic and financial results and breakeven relationships were closely related. Following that correlation, the project priorities were assessed on the basis of the financial results, these being a principal factor likely to influence the implementation of these projects.

7.3 Priorities for Projects

The actual ranking of projects by Kenya will ultimately depend upon a number of factors including the demands for capital as well as the availability of skills and the impact of other government or lending authority priorities. However, experience has shown that the NPV (net present value) represents an effective criteria for early project evaluation. For each project a positive NPV reflects an annual return of at least 15% real in this analysis, provides a guide to the effective use of resources, and attributes to it an absolute priority relativity (even when grouped in different ways to permit comparisons with other similar projects).

In this analysis, therefore, projects were therefore listed in NPV order within categories, with the most attractive projects having the greatest NPV beginning each list. Each of the project categories was then considered in turn, with the analysis providing one or more price figures at which the NPV would be reduced to zero (those figures being designated as the "breakeven" prices for the project, i.e. the price(s) at which the project would yield a 15% p.a. real return).

The projects in each list were reviewed against the current and expected prices for fuel oil, fuelwood and/or electricity as appropriate. The ranges of prices used are set out in Table D.12. In general it was seen that those projects with lower NPV's were the most susceptible to falling oil prices or rising fuelwood prices, while the low electricity tariffs current in Kenya had more wide ranging impact.

It will be appreciated that this analysis was designed to check the apparent viability of the projects. Other factors will come into play determining whether or not to proceed, including the results of more detailed feasibility studies, and the practicability of implementing a number of projects at the one time.

TABLE D.12: KENYA FUEL PRICE RANGES

Fuel	Financial Price	Economic Price
	KSh/GJ	KSh/GJ
Fuel Oil****		
- high	75	81
- base	72	51
- low	55	45
Fuelwood		
- high	65 *	68
- base	38	43 **
- low	18 *	36 **
Electricity		
- high	206	425 ***
- base	164	392 ***
- low	147	330 ***
Coal		
- high	60	62
- base #	50	52
- low #	40	42

Source notes: All data derived in this Appendix with the exceptions noted.

* ESMAP, Peri-Urban Charcoal/Fuelwood Study, Phase 1 Report, Working Paper VII.
** ESMAP, op cit., medium value doubled to allow for transport and same amount added to low value.
*** Relevant hydroelectric studies.
**** By agreement with ESMAP and MOERD July 1986.
# Appendix D figure less 10 KSh/GJ and 20 KSh/GJ respectively.

<u>ANNEX 1</u>

<u>CURRENT NAIROBI RETAIL AND WHOLESALE PRICES OF PETROLEUM PRODUCTS</u>

(KSh/1000L)

PRODUCT	COMPANIES TAKE (IN BOND) MOMBASA	GOK TAKE (TAXES)		MOMBASA DEPOT (WHOLE-SALE)	KENYA RAIL-WAYS FEE	COMM. OF LANDS FEE	JKA (KPC) FEE	KPC FEE	NAIROBI DEPOT (WHOLE-SALE)	RETAIL MARGIN	TOWN DELI-VERY	NAIROBI RETAIL
		IMPORT DUTY	SALES TAX									
LPG (1000kg)	5781.90	216.90	401	6399.80	430	-	-	-	6829.80	550	110	7379.80
PMS	4666.60	653.40	2643	7963.00	-	-	-	304	8267.00	305	38	8610.00
Gasohol	20.00	415.21	2643	-	-	-	-	304	8267.00	305	38	8610.00
RMS	4487.60	653.40	2352	7493.00	-	-	-	304	7797.00	295	38	8130.00
I.K.	3510.60	203.40	100	3814.00	-	-	-	304	4418.00	214	38	4370.00
AGO (LIGHT DIESEL)	3821.40	435.60	1078	5344.00	-	-	-	304	5648.00	254	38	5940.00
JET KEROSENE (JET AI-US$/BBL)	4722.78	152.10	100	4974.88	-	274	400	-	5648.88	-	-	4370.00
MARINE GAS OIL (MGO)	4248.00	-	-	-	-	-	-	-	-	-	-	-
INDUSTRIAL DIESEL OIL (IDO)	3415.00	-	-	-	296.10	-	-	-	3711.10	-	56	3767.10
FUEL OIL (FO 125 CST)	2255.00	-	-	-	320.35	-	-	-	2575.35	-	56	2631.35
FUEL OIL (FO 180 CST)	2181.00	-	-	-	320.35	-	-	-	2501.35	-	56	2557.35
FUEL OIL (FO 280 CST)	1886.00	-	-	-	320.35	-	-	-	2206.35	-	56	2262.35
POWER ALCOHOL	-	-	-	-	-	-	-	-	7300.00	-	-	-
BITUMEN	2845.00	1980	-	-	-	-	-	-	-	-	-	-

Source: GOK, Ministry of Energy and Regional Development, 1985

APPENDIX E

INDIGENOUS AND BYPRODUCT FUELS

APPENDIX E - INDIGENOUS AND BYPRODUCT FUELS

1. INTRODUCTION

Wood and bagasse are the dominant biomass or waste fuels used by Kenya's industry 1/. Other sources include coffee husks, wood waste, tyre scrapings, cashew wastes and byproduct from sawmills and forest operations.

The principal factors limiting use of byproduct fuels in industry are:

- The added cost and inconvenience of processing byproducts into useable, uniform fuel.
- The requirement to collect byproduct fuels often from a wide range of dispersed sources associated with unreliability of supply. Suppliers are not committed to the supply of fuel. As a result, users require flexibility to cope with supply changes.

The principal factors favouring their use are:

- The low cost of the basic fuel.
- The reduced direct foreign exchange component.

The availability of byproduct depends naturally upon the extent of internal use by the producing industry. Moreover, the volume and form of byproduct fuels will be influenced by two major potential sources of byproduct energy which are sawmilling and sugar milling. Sawmills market most of their byproduct direct to consumer; few sawmills are equipped to use sawdust to produce steam and electricity and hence they use other fuels. There may be an opportunity to increase utilisation of byproduct within the wood industry both as energy and as feedstock for building materials. For the time being, however, sawmill byproduct is available for sale. Sugar mills market essentially none of their byproduct. Most burn it to produce steam and electricity and to dispose of the waste. There would seem to be an opportunity to assist the Kenyan energy position, e.g. by increasing the supply of electricity through energy conservation and fuel processing in the sugar industry.

1/ H.M. Jones, "Industrial Energy Use in Kenya: Results and Analysis of a Survey of Major Industries" Kenya Renewable Energy Development Project (Nairobi: MOERD October 1983) p. iv.

2. FOREST RESOURCES

Forest resources of potential value as fuel arise from thinning of the growing forest, the slash remaining from clear felling and the yield from hardwood, fuelwood, forest and sawmill residue.

Forest management in Kenya consists of pulpwood management in Western Province, sawlog management in the rest of the country and interspersed fuelwood plantations. The distribution of production in 1983 is shown in Table E.1.

Recorded production by species and use is shown in Table E.2. The data in this table are somewhat approximate. In particular, the volume of timber removed by fuel ticket holders is very roughly estimated. Fuel tickets are issued freely and allow the holder to remove one 'head-load' of fuelwood per day; there are different fees depending on whether or not the holder is allowed the use of an axe.

The decline in fuel ticket volumes is explained by increasing restrictions on access to the indigenous forest, which is preferred for fuelwood, and the longer distances which ticket holders have to travel to reach plantation forests. Fuelwood is not available from sawlogs or from pulp wood, but does arise from clear felling slash, thinnings and sawmill residues.

TABLE E.1

KENYA: FOREST PRODUCTION BY DISTRICT 1983 (cubic metres)

District	Sawlog	Plywood	Pulpwood
Kiambu	84,773	-	-
Muranga	6,697	-	-
Kirinyaga	4,193	-	-
Nyeri	9,766	-	-
Nyandarua	-	-	-
CENTRAL	142,287	-	-
Laikipia	4,322	-	-
Baringo	16,302	-	-
Kericho	29,345	4,416	-
Narok	-	9,247	-
Uasin Gishu	8,788	2,744	240,812
Kajiado	-	-	-
Nakuru	125,000	12,000	-
Nandi	2,000	700	-
Elgevo	1,732	20,318	-
Trans Nzoia	4,096	-	-
Samburu	273	-	-
RIFT VALLEY	191,858	49,425	240,812
Kakamega	215	6,209	45,136
Bugoma	-	1,091	-
WESTERN	215	7,300	45,136
Meru	10,606	-	-
Embu	2,171	-	-
Machakos	551	-	-
EASTERN	13,328	-	-
Lamu	239	-	-
Kilifi	1,909	-	-
Kwale	1,467	-	-
Taita	5	-	-
COAST	3,620	-	-
TOTAL	351,308	56,725	285,948

Source: Forest Department.

TABLE E.2

KENYA FOREST PRODUCTION

('000 cu.m stacked)

Year	Forest Department Soft Wood	Forest Department Hard Wood	Public Use Firewood	Public Use Charcoal	Public Use Fuel Ticket	Public Use Total
1975	232	304	49	109	31	189
1976	327	332	64	115	68	247
1977	331	414	90	58	56	204
1978	388	426	167	16	44	227
1979	368	423	7	1	20	28
1980	408	482	50	-	40	90
1981	550	475	59	-	81	140
1982	311	366	50	1	92	134
1983*	164	173	33	-	84	117

Source: Forest Department and Central Bureau of Statistics Statistical Abstract 1984

* Provisional.

2.1 Slash and Thinnings

Clear felling slash and thinnings are very little used as fuelwood because they are in remote locations and dispersed over quite wide areas. Collection of thinnings and slash has not yet become commercialised.

In practice, the Forest Department has difficulty disposing of thinnings. Pulpwood can be derived from thinnings, but the dispersion of thinnings over wide areas discourages this. Use of thinnings for poles is being encouraged but species other than pulpwood are normally preferred and pole treatment plants are located in Nairobi, far from the forest. Thinnings do get used as firewood by nearby residents and by small operators who do not have a permanent stumpage allocation.

In some cases thinning is deferred or not carried out because thinnings cannot be sold. As urban fuelwood prices rise, a market for thinnings should develop and users of fuelwood in the rural areas will find the prices which they must pay rising in concert.

Use of thinnings could be a significant fuel opportunity for users willing to develop equipment and techniques for recovering them from remote forest areas. Previous estimates of volume range from 25,000 tonnes per annum presently available and readily accessible to centres of population (Openshaw 1982), to the Forest Department estimates of a possible total of 400,000 cubic metres per annum 1/.

During the life of sawlog and plywood plantation forests two thinnings are caried out; at about 8 and 13 years after planting. These thinnings produce material which is unsuitable for sawmills but at the same time they have the effect of improving the future crop of sawlogs or peeler logs. Table E.3 provides details.

At present, these thinnings are either not cut for lack of suitable market, are left to rot in the forest or, if close to population, are used as firewood. Collection of these thinnings as fuelwood would be a costly task because they are dispersed over wide areas, where roads are poor or do not exist. Commercial collection of these thinnings would therefore involve a substantial logistics exercise.

Table E.4 provides broad estimates of a costing basis - using a suggested collection system yielding 1 truckload or 7 cubic metres per day. (In practice, a four wheel drive tractor and four wheel trailer could be used with the tractor having a power take off to drive a winch and possibly a chipper).

Labour productivity in thinning has been estimated from data prepared by K. Openshaw 2/.

1/ B.D. Kahuki, "Raw Material Resources for obtaining fibrous semi-products for production of paper and board", mimeo. Nairobi: Forest Department, September 1984.

2/ K. Openshaw, "Costs and Benefits Proposed Tree Planting Programme for Satisfying Kenya's Wood Energy Requirements", mimeo (Nairobi: Beijer Institute, 1982) Appendix 10. This is itself developed from Harvesting in Man-Made Forests in Developing Countries, F.A.O., Rome : 1976.

TABLE E.3

POTENTIAL THINNING YIELD IN SAWLOG/PLYWOOD MANAGEMENT

'000 cubic metres

PROVINCE AND DISTRICT LOCATION	1985	1990
CENTRAL		
Kiambu	91.17	64.21
Muranga	8.03	6.21
Kirinyaga	2.12	2.52
Nyeri	21.18	31.92
Nyandarua	26.82	25.74
RIFT VALLEY		
Laikipia	12.20	27.03
Baringo	49.63	47.02
Kericho	56.17	70.84
Nakuru	108.99	123.99
Elegeyo	11.80	16.04
Trans Nzoia	8.24	16.15
WESTERN		
Bungoma	2.52	8.67
EASTERN		
Meru	17.94	26.43
Embu	6.72	-
Machakos	-	8.35
COAST		
Kwale	8.18	11.62
TOTAL	431.71	486.74

Source: C.D. Kahuki, "Raw Material Resources for Obtaining Fibrous Semi-Products for Production of Paper and Board" mimeo, Forest Department, Nairobi 1984, Appendix III.

TABLE E.4

POSSIBLE ANNUAL COSTS OF 7 CU.M OF THINNINGS PER DAY AT ROADSIDE

	KSh
Tractor - Trailer*	300,000
Staff 23 @ KSh 20 per day, 250 days	115,000
Other	25,000
	440,000
Output (1750 cubic metres p.a.)	1500 tonnes
Average Cost	KSh 295/tonne

* Annual vehicle costs per vehicle at KTDA are about KSh 110,000. Estimated economic capital cost of an Isuzu flat bed lorry with high walled body is about KSh 360,000. Estimated total annual capital and operating costs are assumed to be KSh 300,000 p.a., providing for forest working conditions with newer equipment than that for which the KTDA estimate applies.

Source: See text.

The cost per tonne is in the order of KSh 300 but could vary depending upon the vehicle capital and operating costs assumed. If a further KSh 300 per tonne is allowed for transport to the user and for conversion into fuel based on the costs in Appendix D, Table D.9, the total cost averages KSh 600 per tonne.

It may be economic to undertake thinning of Kenya's plantation forest as a fuel production venture provided a reliable market for the fuel can be developed and forest management can be maintained. Moreover, effect of thinning is to increase forest yields.

These estimates suggest that about 130,000 tonnes per annum of fuelwood could be available from a forest thinning and fuelwood production program. Prices within 50 kilometres of the forest would be in the order of KSh 600 per tonne. At 30 percent moisture content weight basis this yields fuelwood at KSh 42.25/GJ.

2.2 Sawmill Residues

Sawmill residues, consisting of bark (12%), sawdust (15%) and offcuts and trimmings (33%) account for 60 per cent of roundwood volumes used by sawmills. Sawmill byproduct is 50 percent moisture, has a density of 730 kg per cubic metre and a gross specific energy of 10.2 GJ/t.

Sawmill residues find a ready market. Offcuts are used in construction where the bark covered slab is a popular fencing and house cladding material. Butts, trim and edges sell well as firewood, bringing KSh 100 per load of about 1 tonne. Where the sawmill is deep in the forest, sawmill and forest workers may be given some offcuts and trimmings for their own use. Less than 20 percent of all sawmills are located deep in the forest because this makes it difficult to market their product and residues. However, some large sawmills are in remote areas.

Perhaps 30 percent of the offcuts of remote sawmills and their sawdust is available for use elsewhere. Sawdust from mills near population centres finds a ready sale at about KSh 2 per sack of about 25 kg. It is used as fuel, in stables and in soil.

According to Forest Department data 1983,sawmills in Kenya processed just over an estimated 420,000 cubic metres of round logs. of residues. Table E.5 gives the volumes and locations of these mills.

Of the total of 250,000 of cubic metres of residue resulting from the production of these logs:

- 10 to 15 percent was sawdust;
- 33 percent was offcuts, of which 15 percent was in forest, leaving 18 percent of offcuts potentially available.

The volume of residue which could become available as an industrial fuel would depend upon amounts retained for other use. Visits by the Consultants to sawmills brought out that over two thirds of the sawdust and up to one third of the offcuts and trimmings could be obtained by an industrial user willing to collect it and pay at least KSh 100 per tonne weight. On this basis the Consultants concluded that a total of about 15 percent of the log volume should be available, and this is used in Table E.5.

On the other hand, the industrial use of sawmill byproduct would affect supplies available for household fuel, livestock producers and others. Substitute products to meet these demands may not be readily available, in which case the price of sawdust might be bid up or the material may not be available. Certainly the emergence of an organised buyer of sawmill byproduct would stimulate efforts to supply, provided prices are attractive.

TABLE E.5

ESTIMATES OF SAWMILL RESIDUE 1983/84

Province and District Location	Number of Sawmills	Roundwood Milled	Byproduct*	Byproduct
	No.	Cubic Metres	Cubic Metres	Tonnes
RIFT VALLEY				
Elgeyo Marakwet	3	22,066	3,300	2,400
Baringo	21	26,649	4,000	2,900
Kericho	16	36,260	5,400	4,000
Trans Nzoia	5	4,776	700	520
Laikipia	5	1,852	280	200
Nakuru	62	139,094	20,900	15,200
Nandi	1	2,000	300	220
Uasin Gishu	9	27,936	4,200	3,060
Samburu	2	150	20	10
WESTERN				
Bungoma	7	13,702	2,060	1,500
Kakamega	1	220	30	20
CENTRAL				
Kiambu	19	77,520	11,600	8,490
Kirinyaga	11	2,390	350	260
Nyandarua	19	6,512	980	710
Nyeri	10	46,195	6,900	5,060
EASTERN				
Embu	4	1,060	160	120
Meru	41	13,602	2,000	1,490
COAST				
Kilifi	1	200	30	20
NAIROBI	4	2,345	350	250
TOTAL	241	424,529	63,560	46,430

Note: * Approximately 5% of byproduct (Section 2.2).
Source: Department of Forestry

Furthermore, the continued growth of building material demand in Kenya in order to house a rapidly growing urban population may lead to conversion of more timber industry residues into chip board and particle board. Sawmills themselves would then use more residues as fuel, especially for kilns, and would produce less residue as modern saws replace circular saws.

The future of sawmill residue as fuel will depend upon the willingness of users to pay for the residues they use and the arrangements to collect them from more than two hundred sawmills in Kenya.

2.2.1 Costs of Sawmill Residue

Some sawmill operators already sell byproduct. Prices do vary. One very small mill quoted KSh 1.5 per wheelbarrow load of sawdust and KSh 1.10 per foot for offcuts. Another suggested between KSh 250 and KSh 400 per truck load. A minimum charge at the mill would be about KSh 100 per tonne.

Sawdust and offcuts are low density materials and collection would require dedicated management. One sawmill owner was attracted by the idea of supplying sawdust (instead of fuelwood) to existing users of fuelwood, especially the Kenya Tea Development Authority. This substitution would free more logs for sawmilling while continuing to meet fuel demands and at the same time removing a waste from sawmills.

The collection of sawmill byproduct would be a substantial enterprise because of the requirement for close control over purchases from several suppliers for whom the material is of low value. The collection system would need to be carefully designed and may include such elements as:

- containers with lids and a capacity of about 2 cubic metres to be left at sawmills and exchanged for empty when full;
- lorries with a capacity to lift and weigh containers at the sawmill when picking up to allow issue of receipts;
- weigh-in checking at delivery;
- sorting, screening and pulverising facilities at the using plant.

No detailed costing of the collection system has been undertaken, but based on figures given above a minimum provision would be KSh 300 per tonne. This would bring the minimum cost of sawmill byproduct to KSh 400 per tonne. This would not include the cost of fuel processing and storage for the user.

2.3 Fuelwood

Openshaw 1/ has estimated the yield of fuelwood from all sources in Kenya. He obtains a total fuelwood yield of 22.8 million tonnes (see Table E.6), including 16.4 million tonnes which might not be exploitable, such as trees on rangeland and yield from tea and coffee bushes presently used as mulch.

1/ Keith Openshaw, Inventory of Biomass in Kenya: Conditionally Renewable Energy (Nairobi: The Beijer Institute, 1982).

Apparently based on this source, O'Keefe, Raskin and Bernow 2/ provide an estimate of the yield of woodfuel in Kenya. This is shown in Table E.7.

In addition, estimates of supply of fuelwood from yield, for present and future demands, are provided in the National Energy Policy 3/. These are shown in Table E.8.

TABLE E.6

ESTIMATED SUSTAINABLE OFFTAKE OF FIREWOOD BY PROVINCE
1980

'000 tonnes air dry (15% mcbw)

	Yield From Range Land	Yield From Exploitable Forest	Yield From Urban Trees	Firewood Yield From trees on Agricultural Land	Yield From Tea & Coffee Bushes and Shade Trees on Coffee Areas	Total Yield (PJ)
Nyanza	2	4.7	0.7	459.3	23.5	490 (7.0)
Western	0	131.7	0.9	235.2	3.9	372 (5.3)
Central	7	495.9	2.1	561.4	113.7	1180 (16.8)
Nairobi	0	33.6	1.2	25.2	5.7	66 (0.9)
Eastern	4476	250.3	1.4	1252.4	79.1	6059 (86.0)
Coast	2434	118.4	0.8	357.5	-	2911 (41.3)
Rift Valley	4432	1428.6	2.4	1043.1	52.4	6958 (98.8)
North East	4479	-	0.1	-	-	4479 (67.4)
TOTAL	15830	2463.2	9.6	3934.1	278.3	22515 (323.5)

Source: Keith Openshaw, op cit Table 11, p.24; and Table 16, p.34, Table 19, p.39; Table 23, p.45.

2/ Phil O'Keefe, Paul Raskin and Steve Bernow. Energy and Development in Kenya: Opportunities and Constraints, Vol. 1 of Energy, Environment and Development in Kenya (Stockholm: The Beijer Institute, 1984)

3/ Kenya, Ministry of Energy and Regional Development, National Energy Policy.

TABLE E.7

TOTAL WOOD YIELDS BY PROVINCE AND LAND TYPE

'000 tonnes per annum

Province	Large Farm	Small Farm	Built	Parks	Forests Woodlots Plantation	Savanah Range	Total
Western	30	1620	30	-	620	-	2300
Nyanza	180	2190	50	60	10	20	2510
Rift Valley	1380	170	10	60	1020	3670	6310
Central - Nairobi	800	750	20	120	880	40	2630
Eastern	220	320	20	70	110	3330	4070
Coast	140	180	-	70	50	1500	1940
North Eastern	-	-	-	-	-	540	540
Total	2750	5230	130	380	2690	9100	20300

Source: O'Keefe et al, eds Energy and Development in Kenya, Opportunities and Constraints (Stockholm: The Beijer Institute, 1984) Table 4.8, p.67.

Demand for fuelwood is not an observed aggregate in Kenya. Overall demand for fuelwood in Kenya is estimated from disaggregated end-use estimates relying upon extrapolation of sample group behaviours to the whole population. The original work was undertaken in 1980 and is reported in O'Keefe, Raskin and Bernow (1984).

Neither is the supply of fuelwood an observed aggregate in Kenya.

The end-use approach to estimation is the sole source of information about aggrgate usage. The original work in 1980 is well regarded and authoritative. Nevertheless, more recent data provide no way of confirming or testing the original work.

In effect, the fuelwood problem is defined by confronting scaled up energy use demands with estimates of forest yield, location by location.

TABLE E.8

NATIONAL WOOD RESOURCE SUPPLY/DEMAND IN KENYA

(millions of tonnes)

		Year				
		1980	1985	1990	1995	2000
Demand		20.41	26.42	32.37	41.04	49.74
Supplies						
- yield	1/	11.07	9.41	8.06	6.29	4.97
- stock	2/	9.26	10.94	13.51	21.62	12.16
Shortfall	3/	.80	6.07	10.80	13.13	32.61
Remaining Standing Stock		934.82	885.41	829.36	744.49	674.40

Source: Ministry of Energy and Regional Development, National Energy Policy, 1985.

1/ Net annual production from accessible forest.

2/ Net reduction in accessible standing stocks.

Note
3/ The term "Shortfall" is not strictly correct. Either demand will be restricted, or supply will be extended, probably both under the influence of rising price.

2.4 Fuelwood Plantations

The cost of wood from plantations comprises land costs, growing and harvesting costs and transport costs. Forest Department calculations dating from 1980-81 and reported on in Appendix C of the companion report "Energy Efficiency in the Tea Industry" result in estimates ranging from KSh 300 to KSh 400/tonne for wood. While these calculations have been inflated by 40.3 percent to account for inflation between 1980-81 and 1984-85, the Department used a discount rate of only 10 percent and included an opportunity cost for land. Stated in energy equivalent terms these estimates suggest an economic cost of fuelwood, excluding land opportunity costs, of KSh 23.2 to KSh 28.2/GJ. A great deal more detail on the value of fuelwood from plantations has been prepared in the parallel GOK:IBRD Peri-Urban Fuelwood Study.

3. CROP RESIDUES

Kenya's production for sale of principal crops is indicated in Table E.9.

Each crop has some byproduct which is potentially usable as fuel.

Crop production is decentralised and Table E.10 indicates the distribution of the main growing areas.

TABLE E.9

KENYA: PRINCIPAL CROPS

PRODUCTION FOR SALE

	Sugar Cane 1/	Maize 2/	Wheat	Clean Coffee	Sisal	Rice Paddy	Seed Cotton	Pyrethrum Extract
	'000 metric tonnes							
1977	1,888.1	424.0	169.9	97.1	32.2	41.4	16.3	0.1
1978	2,349.2	236.3	165.9	84.3	31.5	35.8	27.2	0.1
1979	3,147.6	241.7	201.0	75.1	36.5	37.5	27.6	0.1
1980	3,972.2	217.9	204.6	91.3	46.9	36.4	38.1	0.2
1981	3,822.0	472.9	214.4	90.7	41.3	38.7	25.5	0.2
1982	3,107.7	571.7	234.7	88.4	50.0	38.6	24.4	0.3
1983	3,188.1	637.1	242.3	95.3	49.7	33.6	25.8	0.1

Source: Statistical Abstract, 1984.

1/ Including cane delivered to the sugar factories for the production of white sugar.

2/ Deliveries to the Marketing Board only.

3.1 Bagasse

Bagasse as a byproduct fuel was considered in the Kenya Renewable Energy Development Project 1/. More recently, the Kenya Sugar Authority has also considered the potential availability of excess bagasse in the sugar industry 2/. These results are summarised in

1/ Annex 6.4: Fuel Substitution

2/ Kenya Sugar Authority, Internal memorandum KSA/C/59/Vol. II/15, 9 October 1985.

Table E.11. A potential for 270,000 tonnes of excess bagasse exists. While in reality net yield could be less than this, current practice not only yields no excess, but results in the sugar industry utilising both fuel oil and fuelwood. Outside the Sugar Industry delivered bagasse costs would have a large transport component and could total KSh 400 per tonne, of which between KSh 100 and KSh 200 would be paid to the supplier.

Bagasse could be used to generate electicity for sale to Kenya Power and Lighting Company (KLPC). There would be some difficulties, however, since not all plants are connected to the national grid. More importantly, to date KPLC has been willing to pay only its own saved operating costs for power obtained. The reason given is that sugar milling coincides with periods of high water flow and rainfall, with the marginal savings in power generation being at low hydroelectric rates until water storage became available.

Higher rates might now be available. Surplus bagasse could also become available as a solid fuel (or as fibre for papermaking). It would require baling and possibly pelletising as well as transport and storage away from the sugar factory sites. The factories would also require some payment to warrant the effort in achieving more efficient operation of their plants. This would have the advantage of supplying a thermal fuel which could substitute for oil.

TABLE E.11

KENYA SUGAR INDUSTRY: POTENTIAL SURPLUS BAGASSE 1984

(Tonnes)

Plant	Sugarcane Ground	Bagasse Made	Bagasse Used	Excess Bagasse
Mumias	1,483,464	474,708	408,482	66,226
Chemelil	573,172	208,119	156,355	51,764
Muhoroni	490,036	210,519	133,620	76,899
Nzoia	307,288	104,539	83,788	20,751
Sony	379,663	141,728	103,530	38,198
Miwani	263,132	104,463	95,669	8,794
Ramisi	89,718	31,850	24,468	7,382
TOTAL	3,586,473	1,275,926	1,005,912	270,014

Source: Kenya Sugar Authority
Bagasse 50% moisture content.

3.2 Grain Byproducts

In 1983 Kenya produced 637,000 tonnes of maize for sale and 242,000 tonnes of wheat with wheat straw and maize cobs being separated from wheat and maize on the farm.

There was an attempt to utilise maize cob in Kenya at Eldoret. Cob was used to produce Furfurol, which is a lubricant used in oil drilling; however the project failed after 6 months' operation as the cob collection costs are believed to have excluded any market price for the cob.

Virtually all of the marketed wheat is milled in Kenya yeilding 10 percent by weight as bran (24,000 tonnes in 1983). About 10 percent of this bran is used in cattle feeds as a filler; it has little nutritional value. Recent prices of bran for feed have been KSh 51 per 45 kg bag or KSh 1,330 per tonne. If this market builds up, the supply available for use as fuel may fall. About half of the marketed maize would be milled to yield bran so that the weight of maize bran is approximately 5 percent of the maize marketed or 32,000 tonnes.

Total bran supplies in Kenya therefore amount to about 55,000 tonnes, of which at least 50,000 tonnes is not, at present, used in alternative ways. Bran is distributed according to the location of maize and flour milling capacity. This was reported in 1982 as shown in Table E.12.

TABLE E.12

GRAIN MILLING CAPACITY IN KENYA

Province	Number of Mills	Milling Capacity of Grain	1983 Estimated Byproduct
		'000 tonnes per annum	
Rift Valley	5	449	16
Nyanza	3	153	5
Nairobi	7	589	21
Central	3	118	4
Coast	2	238	8
TOTAL	20	1547	55

Note: Errors in addition due to rounding.

Source: Macdonald Wagner Pty Limited, Grain Handling, Storage and Marketing Project, Final Report, Republic of Kenya: Ministry of Agriculture and National Cereals and Produce Board, October 1982.

3.3 Coffee

Coffee production in Kenya in 1983-84 was 130,000 tonnes clean. Table 9 shows historical statistics of coffee production and indicates little growth between 1977 and 1983. The Kenya Planters Cooperative Union (KPCU) expects growth at the rate of 2.5% p.a. to 3.0% p.a. over the next 10 years. The first stage of coffee processing takes place on the estate or in a society owned factory very near the growing area. The red shell of the coffee berry is removed and the two beans are removed. The two beans are fermented and then air dried and bagged for shipment to KPCU. During this process, 7 tonnes of red berry are reduced to 1 tonne of coffee bean. The pulp which is produced in this process is used as fertiliser or soil conditioner and may not be available as fuel. (Further data are available from the Jacaranda Research Station in Ruiru.)

The second stage of coffee processing occurs in KPCU factories in Nairobi, Dandora, Sagana and Meru. Here dried beans are hulled and polished, the husks are pneumatically separated and the beans are graded and packed for shipping.

3.3.1 Coffee Husks

Coffee husks have been used as fuel in Kenya for many years. The quantity of husks produced in any year is related to the quantity of clean coffee produced and is affected by the dryness of the season and the extent of delays in picking. In a dry season, husks form a larger share of the weight of final product. When coffee is picked late, husks become a much larger share of final product and coffee crop is lost.

Late picked coffee is called mbuni coffee and yields 50 percent by weight of husks. It makes up 10 percent to 12 percent of the coffee crop and is processed at Dandora and Sagana. These centres produced 30,000 tonnes of clean coffee in 1983-84, yielding 15,000 tonnes of husks. Of these, 10,000 tonnes were processed into charcoal and sold as Kahawa coal; 3,000 tonnes of Kahawa coal were sold at a price of KSh 1850/ tonne. This charcoal has a calorific value of 29.4 GJ/tonne compared with 25 to 28 GJ per tonne for marketed charcoal.

Coffee which is picked on time is called parchment coffee. It yields 20% by weight of husks, rising to 25% in dry seasons. All Kenya's parchment coffee is processed by KPCU in Nairobi. In 1983-84, 100,000 tonnes of finished coffee were produced in Nairobi and yielded 25,000 tonnes of husks. These husks are sold to East African Industries which uses some of them and markets some as fuel. Transport costs to East African Industries are reported to be KSh 200 per 8 tonnes or KSh 25/tonne.

In summary, at present Kenya produces approximately 35,000 tonnes of dried coffee husks. Of these:

- 20,000 tonnes are produced in Nairobi and are at present contracted to East African Industries,
- 10,000 tonnes are produced in Dandora, Nairobi Province and are committed to the production of 3,300 tonnes of charcoal for sale at KSh 1850 per tonne of charcoal, and
- 5,000 tonnes are produced at Sagana and are available in volume for KSh 20 per tonne of husks in KPCU store.

Total Kenyan production of coffee husks represents 0.53 PJ/a of which only about 0.08 PJ/a is not already committed. Dried coffee husks loosely loaded weigh 0.18 to 0.22 tonnes per cubic metre.

3.3.2 Coffee Pulp

Moisture and pulp make up five sixths of the coffee cherry. The pulp is the outer layer of the cherry and is available where coffee is grown as shown in Table E.13.

For many years various uses have been proposed for the pulp including production of gas in digesters, drying for fuel or charcoal production, and use as fertiliser. Coffee pulp composts readily and is a valuable fertiliser, being high in potassium.

Supply of coffee pulp is available wherever coffee is grown. In the order of 500,000 tonnes per year net weight would be produced in Kenya as a byproduct of 100,000 tonnes of coffee. Pulp is available when the coffee cherry is picked. This is seasonal with peak periods generally occurring April to August and October to December, however irrigated crops yield most of the year.

Coffee pulp is not generally marketed and being acidic with an unpleasant odour is costly to transport. Transport costs would exceed rates for more pleasant cargoes.

Use of coffee pulp as industrial fuel is feasible and its widespread distribution makes it accessible. Its value as a fertiliser would raise the opportunity cost of diverting it to fuel.

Dried coffee husks loosely loaded weigh 0.18 to 0.22 tonnes per cubic metre. Total Kenyan production of coffee husks represents 0.53 PJ/a of which only about 0.08 PJ/a is not already committed.

TABLE E.13

COFFEE PRODUCTION IN KENYA 1983/84

Province and District	Finished Coffee tonnes
NYANZA	
Kisumu	78
Kisii	1,276
South Nyanza	240
RIFT VALLEY	
Kericho	29
Trans Nzoia	380
Nakuru	1,893
Nandi	160
Uasin Gishu	329
WESTERN	
Bungoma	1,071
Kakamega	286
CENTRAL	
Kiambu	52,615
Kirinyaga	9,036
Nyeri	14,215
Murang'a	24,406
EASTERN	
Embu	5,496
Machakos	4,634
Meru	12,218
Kitui	2
COAST	
Taita	104
NAIROBI	473
Other	684
TOTAL	129,625

Source: Coffee Board of Kenya.

3.4 Sisal

Sisal waste was evaluated as a source of supply for paper manufactured by the Japan Consulting Institute in 1978. 1/

Sisal waste, known as sisal flume tow, is produced at the rate of 10-15 percent of sisal produced. It is recovered using a simple mechanical screen. Flume tow is used in the manufacture of bags and twine by East Africa Bag and Cordage Company and by ACIF Ltd., about half having been used in this way.

Sisal production in 1983, primarily from Rift Valley and Coast provinces, was 49,700 tonnes, suggesting a waste level of between 5,000 and 7,500 tonnes of which perhaps half would be available for use as fuel. The distribution of this product may be gauged by looking at the distribution of sisal growing in Table 10.

3.5 Rice Husks

Rice husks form 20 percent of rice paddy milled and are generated at rice mills. There are two mills in Kenya:

	Paddy Milled	Husks Available
Mwea	30,000 tonnes	6,000 tonnes
Kisumu	10,000 tonnes	2,000 tonnes

Rice husk is low density (300kg/cu.m) dry material with relatively low calorific value and low nutritional value. Rice mills dump husk at present and, apart from cogeneration of electricity, have no alternate use for it. Husk shipments from rice mills are in lorries and availability continues year round except for the month of December.

Rice husk may be high in silica and calorific value is expected to be low, in the order of 10 GJ/t. Anticipated delivered cost of rice husk at 35 km radius is KSh 450/tonne.

1/ Japan Consulting Institute, 1978.

3.6 Pyrethrum

Kenya produces up to 300 tonnes per annum of Pyrethrum extract.

In response to a 1984 survey by MOERD, the Pyrethrum Marketing Board at Oakuru replied that it had no byproduct usable as fuel. They do dispose of sludge oil.

Pyrethrum marc, with similar properties to rice husk, in the amount of 900 tonnes is reported as available. Pyrethrum processing also uses fuels including sawdust obtained from nearby sawmills free of charge. This suggests that Pyrethrum marc might be usable as a fuel for pyrethrum processing. The team did not investigate this possibility.

3.7 Coconut Shells

The area of large farms under coconuts is given in Table 10. However, the Special Energy Programme 2/ has estimated that 40,000 ha. are under coconut in 1980 in Kwale and Kilifi, Coast Province. This is 30 times the area shown in Table 10 for large farms, suggesting that many smallholders grow coconut.

The Special Energy Programme assumes 3000 nuts are produced per ha per year, and arrives at an estimate of between 16,800 and 24,000 tonnes of coconut shell which is wasted. About 2000 tonnes of charcoal could be produced from this resource.

3.8 Pineapple Waste

Pineapple processing byproduct is available from Kenya Canners Ltd at Thika. In 1984 there were 50,000 tonnes but anticipated to grow, to 66,000 tonnes by 1986.

The product is the result of juice extraction from the skin and core of the pineapple. It has been used as cattle feed, but the feed lot operation has been disposed of and the present user takes only about 20 percent. It is occasionally used as mulch on coffee when coffee pulp is not available.

1/ KREDP, Industrial Energy Use in Kenya: Results and Analysis of a Survey.

2/ GTZ, Special Energy Programme, Kenya Charcoal Production and Research Policies within the Special Energy Programme, Kenya (Nairobi: Special Energy Programme/Kenya, 1984).

TABLE E.14

COMPOSITION OF PINEAPPLE WASTE

	Composition before final press	Calculated at 30% moisture (as available)	Comment
	% by weight		
Moisture	84.6	30.0	moist to touch
ph	4.1	3.8	corrosive
Nitrogen	0.952	2.1	
Potassium	1.16	2.6	
Calcium	0.178	0.4	
Magnesium	0.132	0.3	
Phosphorous	0.084	0.2	
Sugar		6 to 7	sticky

The product is available from an overhead discharge on a continuous basis with some fluctuation from month to month. It contains long fibres but passes a 66,000 screen.

No economic method of drying has been found. Solar drying will work but it too is uneconomical. Kenya Canners Ltd uses some steam and may be able to use waste heat, but would not be able to dry all this waste. It may be better to install a biological gasifier to supply methane for Kenya Canners and to treat the tailings as fertiliser. Fluidised bed combustion may also be a possible direct use of this product.

3.9 Bixa Seed Waste

Bixa seed is grown in Kwale, Coast Province. At present 1800 tonnes per annum are produced. No price information is available.

The seed is soaked in hydrochloric acid to extract dye and the remainder is largely wasted with some being s used as furnace fuel. The product is seasonal, being available about September.

3.10 Cashew Nuts

Cashew nuts are grown in Kilifi, Coast Province. A reported 7,500 tonnes per year of shells are available and are used by a variety of commercial users 1/. The shells have a high calorific value and are well regarded as fuel.

1/ KREDP

Production of cashew nuts by Kenya Cashewnuts Ltd in 1984-85 is reported as 8,460 tonnes after reaching 12,309 tonnes in 1974-75 1/. The trees have a limited life of 30 years and total yields have apparently fallen. Factory capacity is 15,000 tonnes of nuts per annum and future growth in shell supply depends upon expansion of factories and grower production.

3.11 Other Crop Wastes

There is a variety of other biomass and crop wastes which could be considered. These include:

- barley byproduct from brewing (See BAT audit)
- sunflower seed husks which are a byproduct from East African Industries
- macadamia nut shells
- cotton seeds

4. OTHER POTENTIAL FUELS

This survey was intended to cover the main biomass areas rather than be exhaustive. As a result, fuels such as straw, biomass, and maize husk are all omitted, although they could be suitable for some users. However, animal waste is reported to total 149,000 tonnes wood equivalent 2/. Moreover, about 150 tonnes per year of rubber waste were reported as available in surveys conducted by the Kenya Renewable Energy Programme.

Papyrus has been evaluated as a fuel for Kenya and a summary is provided hereunder.

Municipal waste is noted in the following section but has not been evaluated.

1/ Daily Nation, October 25, 1985.

2/ H.M. Jones, Energy Conservation and Planning: Final Report (Nairobi: Kenya Renewable Energy Development Project, 1985) p.37, Gross specific energy of animal waste is 12.8 GJ/tonne.

4.1 Papyrus

Papyrus as a fuel Was evaluated for Kenya in 1984 1/. The culm or stalk of papyrus when hand cut is 75% moisture by wet weight. It will dry in about 10 days to about 40 percent moisture.

Papyrus, oven dry and ash-free, has a calorific value of 240 GJ/t and an ash content of up to 8%. Its proximate analysis in comparison with wood and bagasse is given in Table E.15.

TABLE E.15

PROXIMATE ANALYSES OF PAPYRUS, WOOD AND BAGASSE

Material	Moisture Content %	Ash (dry wt.) %	Volatiles (dry wt.) %	Fixed (dry wt.) %
Cyperus papyrus	7.9	5.9	9.3	84.8
Cupressus lusitanica	5.1	1.7	14.0	84.3
Eucalyptus saligna	3.4	1.5	16.7	81.8
Pinus patula	1.1	1.5	17.3	81.2
Bagasse	13.3	9.1	17.0	73.3

Unfortunately, papyrus must be compressed to be useful as fuel because in its natural dried state it either burns too rapidly or releases too little heat to sustain combustion. Papyrus, cut into pellets when wet, can be compressed to 1300 kg/cubic metres when dry. It must be kept dry.

The cost of harvesting and manufacturing fuel briquettes from papyrus is estimated as being between $US 2-3 per GJ. It may also be possible to gasify papyrus. These costs make no provision for the opportunity cost, if any, of other uses of papyrus swamp. Nonetheless, papyrus appears more costly than wood at KSh 400/t.

1/ Energy Initiatives for Africa, "Fuel from Papyrus", Gordon Melvin & Partners, and Energy/Development International, USAID Contract No. 16 AFR-0424-0-00-2079-00, August 1984.

TABLE E.16

PAPYRUS LOCATION IN KENYA

Province and Location	Area	Estimated Sustained Yield 1/	Dry Yield 40% mc	Comments
Western Bungoma	18,000	324	130	. 45 km from Busia 0000S 3400E
Nyanza Kisumu	5,000	75	30	. 25 km from Kisumu 0010S 3450E
Kisii	small	-	-	. 55 km S W Homa
Rift Valley Nakuru	1,100	16	6	. Lake Naivasha (would not support briquetting)
Central Kiambu	small	-	-	. Ruiru-Thika
	small	-	-	. Lake Jipe

Source: Energy Initiatives for Africa, "Fuel from Papyrus", Gordon Melvin and Parners and Energy/Development International, USAID Contract No. 16 AFR-0424-0-00-20279-00, August 1984.

1/ Based on 15t/ha/yr. Cutting by hand 8 months per year. Freshly cut 300% moisture by dry weight.

5. MUNICIPAL WASTE

Kenya's urban areas generate waste with Nairobi producing 350 tonnes per day or about 100,000 tonnes per year. Municipal waste is a potential fuel, consisting of about 50 percent combustible materials.

In order to use municipal waste as fuel it is necessary to process it to remove non-combustibles and putrescibles. There is a variety of processes including pyrolysis to gas and sorting and pelletising. All involve substantial capital and operating costs.

Information on one particular process for sorting and pelletising municipal waste was obtained from a distributor. This is given in Table E.17.

TABLE E.17

WASTE DERIVED FUEL

Properties of fuel (pellets)	
Calorific Value	17 GJ/tonne
Ash Content	15%
Costs	
Capital Cost (300 tpd)	$US 4.25 million
Energy Input	35 Kwh/tonne
Installed Power	2000 HP
Staffing	30
Estimated Cost of Fuel	$US 0.71/GJ

For this particular process which recovers some materials, the estimated cost of fuel is based on 88% capital charges and excludes revenue from recovered metal, glass and compost from putrescibles. Transport costs to plant could be additional.

6. SUMMARY

6.1 Volumes Available

The estimated total volume of the more significant byproduct and biomass fuels, except from fuelwood plantations, is shown in Table E.18. The distribution for a selection of these fuels is shown in Table E.19. Tables E.20 and E.21 summarise previous results for comparison.

TABLE E.18

KENYA PRINCIPAL BIOMASS AND BYPRODUCT FUELS

(excluding fuelwood plantations)

Fuel	Availability Estimated	
	'000 tonnes per annum	
Forest		
. forest thinnings and slash	25-400	
. sawmill byproduct	60*	
Crop Residue		
. bagasse (potential)	0-270	
. maize cobs and bran	32	
. wheat bran	24	
. coffee husks and pulp	25	
. sisal flume run	12	
. rice husks	8	
. pyrethrum marc	1	
. coconut shell	20	
. pineapple skin and core	66	
. cashew nuts	8	
Other Biomass and Waste		
. papyrus	160	
. municipal waste/waste paper	100	
. cotton	3	
. tyre scrapings	1	
. animal waste	150	
. bixa seeds	2	
. vinasee	32	**
. green oil		**
. acid oil		**
. sunflower	4	

* Includes sawdust and some offcuts and would compete with domestic users.

** No further data available.

Source: Estimates from previous sections.

TABLE E.19

KENYA: DISTRIBUTION OF MAJOR BYPRODUCT/BIOMASS FUELS

tonnes per annum

Province and District Location	Sawmill Residue t/a	Bran	Coffee Husk	Sisal Flume Run	Rice Husk	Pyrethrum Marc	Coconut/ Pineapple	Cashew Bixa	Papyrus
NYANZA		5,000							
. Kisumu					2,000				30,000
. Kisii									
RIFT VALLEY		16,000							
. Elgeyo Marakwet	3,300								
. Baringo	3,900								
. Kericho	5,400								
. Trans Nzoia	700								
. Laikipia	300								
. Nakuru	20,500			1,400		900			
. Nandi	300								
. Uasin Gishu	4,100								
. Samburu	20								
WESTERN									
. Bungoma	2,000								130,000
. Kakamega	30								
CENTRAL		4,000							
. Kiambu	11,400			400			66,000		
. Kirinyaga	350		5,000		6,000				
. Nyandarua	1,000								
. Nyeri	6,800								
. Murang'a				200					
EASTERN									
. Embu	160								
. Machakos				300					
. Meru	2,000								
COAST									
. Kilifi	30			300			20,000	7,500	
. Kwale								1,800	
. Taita				2,200					
NAIROBI	350	21,000	30,000						
TOTAL	62,700	54,000	35,000	4,800	8,000	900	86,000	9,300	160,000
GJ/t	15.5 (30%) 10.2 (50%)	13.9	15.1	13.9	13.9	13.9		19.7	20.0
Price delivered KSh/t	400	1,000	20	waste	waste	waste	waste	waste	(50 Ksh/GJ)

TABLE E.20

USE OF BIOMASS AND WASTE FUEL IN INDUSTRY

Fuel	Volume	Energy Value	Average Price	
	tonnes	PJ	KSh/GJ	$US/GJ
Wood 1/	171,753	2.74	6.26	0.37
Bagasse 1/	1,064,000	13.35	not traded	
Cashew Nut Hulls 1/	1,253	0.02	22.87	1.35
Coffee Husks 1/	7,800	0.12	1.66	0.10
Sawdust 1/	50	0.0008	12.57	0.74
2/		0.0005		
Tyre Scrapings 1/	90	0.004	2.92	0.17
Green Oil **				
Rice Husks **				
Pyrethrum Marc **				
Sisal Waste 2/		0.2		
Grains 2/		0.5		
Slash in Forest 2/		0.4		
Animal Waste		2.3		

** Data not available.

1/ H.M. Jones op cit, Table 3, Page 6.

2/ Keith Openshaw, "Inventory of Biomass in Kenya: Conditionally Renewable Energy" (Nairobi: The Beijer Institute, 1982) Table 3.

Sources: See Table E.21.

TABLE E.21

REPORTED AVAILABILITY OF BIOMASS AND WASTE 1983

Fuel	Reported Amount 1/	2/ tonnes (air dry)	2/ tonnes wood equivalent
Acid Oil	325,000 litres		
Sawdust	500 tonnes		
Sisal Waste	12,000 tonnes	31,000	18,000
Cashew Sludge	80 tonnes		
Firewood	200 tonnes		
Tyre Scrapings	90 tonnes		
Pyrethrum Marc	900 tonnes		
Green Oil	250,000 litres		
Rubber	500 tonnes		
Vinasee	32,000 tonnes		
Bagasse	1,063,511 tonnes	521,000	378,000
Coffee Husks	7,800 tonnes		
Rangeland Woody Biomass Yield		16 million tonnes 3/	

Source: 1/ H.M. Jones op cit, Table 3, page 6.

2/ Keith Openshaw, "Inventory of Biomass in Kenya: Conditionally Renewable Energy" (Nairobi: The Beijer Institute, 1982) Table 3.

3/ Openshaw, op cit, p.8. He notes that the source is not readily accessible - being over 50 to 100 kms from urban areas and households. The accessibility of this resource will depend upon the price payable for delivered wood.

6.2 Supply of Byproduct Fuels

By definition, byproducts are produced incidentally in the manufacture of other products. If byproducts are to substitute for commercial fuels, they must be reliably available in uniform quality. At the present time, however, the institutions to achieve this are not in place in Kenya, although substantial volumes of fuel may be available.

Institutional options to achieve the requisite uniformity and availability include:

- fuel users, who would organise their own supplies;
- suppliers, who would mount a fuel marketing system;
- private traders who would arrange to purchase surplus and sell on to users;
- a para statal organisation subject to the Ministry of Energy and Regional Development, and/or other Ministries.

Which ever of these options is chosen, a programme of demonstration and institution building appears necessary if byproducts are to be mobilised as fuels in Kenya. A number of policy choices are available. One which appears attractive is to identify potential users of fuel and to licence a number of businesses to supply selected users.

APPENDIX F

INITIAL EVALUATION OF PROJECTS

APPENDIX F - INITIAL EVALUATION OF PROJECTS

1. INTRODUCTION

This appendix outlines the approach used for the initial evaluation of projects in this study.

An evaluation of large scale infrastructure development was not necessary because it became apparent that coal, as a substitute fuel, offered little advantage over oil even before the world price decline, and certainly not enough advantage to warrant new infrastructure. Accordingly, evaluation involved consideration of proposals for improvements to energy utilisation identified in the individual plants or tea factories which were audited. These evaluations were first conducted as part of each audit, with their results reported as simple payback periods, nett present values and internal rates of return. Subsequently they involved sensitivity analysis to check the viability of the projects under changing conditions-as discussed in Appendix D.

Overall the project evaluation process was designed to satisfy several objectives -

- to test whether private investors would achieve reasonable rates of return in the context of present rates of tax, duty and prices;
- to test whether Kenya would achieve reasonable net benefits after taking into account the various economic costs involved; and
- to indicate the impact on project viability of changes in such critical elements as fuel prices.

2. CRITERION

The Consultants considered several evaluation measures including payback period, internal rate of return and net present value. Each measure has advantages for particular users. Payback period is a convenient but very broad basis for assessing projects; internal rate of return and net present value both provide more comprehensive indicators of economic viability. Where there is a variety of external or project conditions to be considered, internal rates of return can become complex and difficult to interpret. Net present value is a powerful and effective basis for comparison and has the further advantage of being able to treat project modifications as sums to be added to or subtracted from any designated total.

For this project, for both private and national evaluations, the net present value was adopted as the basis for individually assessing and then subsequently comparing potential projects. The benefits and costs included in each instance were those pertinent to the particular evaluation.

3. PARAMETERS OF EVALUATION

The principal evaluation parameters were seen to involve the following:

- the discount rate;
- the prices of fuels in market and economic values;
- private sector interest rates, loan conditions, gearing, taxes, depreciation, duties and dividend payout proportions;
- the foreign exchange premium.

3.1 Discount Rate

The public sector discount rate for individual projects in Kenya is 15 percent p.a. This is a high rate, especially when applied to benefits and costs expressed in constant price terms. However, energy conservation programmes are subject to a number of long term uncertainties associated with such matters as prices, new supplies, technological change and market changes. This suggested that high discount rates, which favour projects offering early returns, were appropriate.

Furthermore, although interest rates in Kenya have occasionally fallen behind inflation rates in recent years, it is governmental policy to maintain positive real interest rates if at all possible.

A standard discount rate of 15 percent was selected after consideration of these matters and consultation with the World Bank.

3.2 Prices of Fuels

Economic and market prices were established for the various fuels and are reported upon in some detail in Appendix D -"Supplies and Prices of Fuels".

3.3 Private Sector Investment

A range of different elements was identified as being important to any decisions on investment, including particularly;

3.3.1 Key Factors

The key factors reflected in the evaluations were:

- Corporate tax rates of 45% on profit;
- Depreciation allowance on plant and machinery of 12.5% p.a. on the declining balance and 2.5% p.a. straight line on industrial building;
- Development finance available at 15% p.a. for 10 years with one year grace period and a gearing of not less than 30% equity;
- Other finance at 19% p.a.

No standard return is expected by investment appraisers, but projects yielding less than 25% before interest and taxes are most unlikely to succeed.

3.3.2 Other Factors in Private Investment

An investment allowance of 50 percent of capital expenditure is deductible from profits for firms located outside Mombasa and Nairobi. Deduction is from profit before tax and after interest and depreciation. Accumulated losses can also be written back in later years by firms located outside Mombasa and Nairobi.

Development finance is not available where the items to be acquired cannot be serviced in Kenya and do not generate at least 40 percent value added in Kenya. Approval to obtain foreign exchange must be obtained in advance from the Central Bank. It is Bank policy to encourage use of supplier credit.

3.3.3 Dividends and Repatriation

Kenya allows foreign investors who have obtained a Certificate of Approved Enterprise to repatriate after tax profits in proportion to their investment in Kenya. The extent of repatriation affects national economic benefits but not the individual private sector evaluation.

3.3.4 Import Duties

Exemptions from import duties are not common.

The steps to be followed for an investment project requiring imported components are:-

1. Seek approval from the Ministry of Commerce and Industry for the investment proposed. Applications also seek exemptions from applicable duties. Approval is subject to certain conditions such as a limit on the time for which approval is

granted. One of the conditions of approval may be that no exemption from import duty is sought.

2. Following approval the investor must apply to the Central Bank for a Foreign Currency Allocation. The Central Bank has priorities for foreign currency allocation and will apply these to the project. The Central Bank will encourage use of supplier credit.

   Foreign investors who invest in foreign currency or re-invest profits earned in Kenya will also require from Treasury a Certificate of Approved Enterprise which protects the repatriation of profits and provides protection from compulsory acquisitions.

3. Following approvals and an allocation of foreign currency the investor can place orders and raise letters of credit.

The most common approach to obtaining exemption from duty is to lobby the Government through the Kenya Association of Manufacturers for a general change in duty on the appropriate items. During 1985 the Investment Advisory and Promotion Centre, which is charged with facilitating foreign investment in Kenya, was lobbying for import duty relief on plant and equipment. The Investment Advisory and Promotion Centre is a unit of the Ministry of Planning and National Development.

In general, sales tax is not levied on items of plant and equipment.

The following Table gives applicable rates of import duty and sales tax for selected items of relevance in the energy field.

KENYA: RATES OF IMPORT DUTY AND SALES TAX, 1985

ITEM	Tariff Code	Rate of Duty	Sales Tax
CONTROL EQUIPMENT			
Oxygen Analyser	90.25.009	25%	17%
Carbon Monoxide Analyser	90.25.009	25%	17%
Flow Transmitter	90.24.009	35%	17%
Temperature Transmitter	90.23.009	35%	17%
Pressure Transmitter	90.24.009	35%	17%
Pressure Change Transmitter	90.24.009	35%	17%
Indicating Controllers	90.28.019	25%	17%
Recording Controllers	90.28.019	25%	17%
Thermometers	90.23.009	35%	17%
Pressure Gauges	90.24.009	35%	17%
Control Valves (electronic automatic)	90.28.019	25%	17%
Control Actuators .	90.28.019	25%	17%
.	90.24.009	35%	17%
MECHANICAL EQUIPMENT			
Temperature Control Valves	84.61.000	30%	17%
Pressure Reducing Valves	84.61.000	30%	17%
Manual Valves	84.61.000	30%	17%
Pipe Fittings	73.20.000	25%	17%
Insulation	69.01.000	Free	Free
Tanks	73.22.000	45%	17%
Boilers	84.01.010	25%	Free
Burners	84.13.000	25%	Free
Pressure Vessels	73.24.000	45%	Free
Combustors	84.13.000	25%	Free
Gasifiers	84.03.000	25%	Free
Economisers	84.02.010	25%	Free
Steam Traps and Ancillary Equipment	84.02.010	25%	Free
Condensate Return Pumps	84.02.010	25%	Free
ELECTRICAL EQUIPMENT			
AC Motors	85.01.020	25%	Free
Switch Boards)	85.19.019	40%	17%
Switch Gear)			
Circuit Breakers)	85.19.019	40%	17%
Cabling 2mm to 7.7cm	85.23.001	40%	17%
0.2mm to 2 mm	85.23.002	80%	17%
Transformers			
- Liquid Dielectric	85.01.070	25%	Free
- Other	85.01.080	25%	Free

3.4 Foreign Exchange Premium

3.4.1 Background

Foreign exchange allocation in Kenya is managed by the Government of Kenya in order to increase the share of scarce foreign exchange which is available for investment in development and growth. National development priorities and targets influence the allocation of available foreign exchange. Quantitative restrictions on imports in Kenya are a policy response to limited foreign exchange availability. Imports to Kenya are subject to duty and import taxes have averaged about 17 percent in recent years.

The official approach to the exchange rate has been flexible, and substantial devaluations against the Dollar and the Yen occurred during 1984. The exchange rate is managed by reference to a group of currencies. Currency variations create exchange risks for Kenyan borrowers of foreign currencies.

Official policy of the Central Bank of Kenya is to promote use of overseas credits to finance imports where acceptable terms and conditions of credit are available. Long term credit is favoured for imports of capital items.

Overseas financing of exports is not normally approved. This is significant because it restricts early repatriation of export sale proceeds by overseas controlled organisations. It also restricts the ability of borrowers to obtain hedging protection against exchange rate variations.

Investors in plant and equipment in Kenya are generally encouraged to use overseas credits when they are available on suitable terms, but are not able to hedge foreign exchange risks, e.g. by selling exports in future markets or by currency swaps.

This means that both private investors and the nation have an interest in minimising foreign exchange exposure and expenditure. It is therefore appropriate to apply a premium to foreign exchange payments and revenues.

3.4.2 Premium Adopted 1/

The foreign exchange premium adopted for the study was 20 percent. This was applied as a test of private investment as well as in any assessment of national economic returns.

1/ The content of this Section was prepared by Ng'ang'a Munyu of the MOERD staff.

The information set out below on appropriate shadow exchange rates for Kenya was obtained from calculations using import figures, discussions with officers in the Ministry of Finance and Planning, and the current rates on the black market.

a) Calculation Using Import Figures

From Squire and van der Tak, the standard formula 1/ for calculating the shadow exchange rate is as follows:

$$\frac{\text{Standard Conversion Factor (SCF)}}{\text{Official Exchange Rate (OER)}} = \frac{1}{\text{Shadow Exchange Rate (SER)}}$$

OR

$$\frac{SCF}{OER} = \frac{1}{SER}$$

$$SER = OER / SCF$$

For the Kenyan case, studies of the shadow price of foreign exchange 2/ suggest that the simple formula leads to better results than more complex alternatives. This simple formula is as follows:

$$SCF = 1/(1 + tm)$$

where tm = the average import tax, and 1/

$$tm = \frac{\text{Total Import Duties (TID)}}{\text{Total Imports (TI)}}$$

Using the simple formula in the following table, the average foreign exchange premium for the period from 1979 to mid 1985 was 15.8 percent.

1/ Squire, L. and van der Tak, H.G., Economic Analysis of Projects, (Baltimore: The John Hopkins University Press, 1975).

2/ Tigani, E.A., "Kenya: Study of General Shadow Prices", Washington: International Bank for Reconstruction & Development, mimeo, 1980).

KENYA: FOREIGN EXCHANGE PREMIUM (FEP)

YEAR	TID M KSh	TI M KSh	tm	SCF	OER*	SER	FEP (%)
1979	1,806	12,403	0.1456	0.873	7.328	8.395	14.56
1980	2,408	19,181	0.1255	0.888	7.568	8.518	12.55
1981	3,009	18,648	0.1613	0.861	10.286	11.946	16.13
1982	3,171	18,006	0.1761	0.850	12.725	14.966	17.61
1983	3,039	18,104	0.1679	0.856	13.760	16.070	16.79
1984	3,762	21,895	0.1718	0.853	15.781	18.492	17.18
1985	-	-	-	0.864 +	16.1433 ++	18.695	15.81

Notes: * As as 31st December.
+ Average of the previous SCF figures for 1979 - 84.
++ Exchange rate on 27/6/85.

b) Discussion with Ministry of Finance and Planning

Officials in the Ministry of Finance and Planning suggested that when the official exchange rate was around KSh 16 per $US 1, the corresponding shadow exchange rate was estimated to be around KSh 20 to $US 1. This gave a foreign exchange premium of 25 percent.

c) Black Market

In the black market the selling price of $US 1 in mid 1985 was around KSh 19-20. Using KSh 19.50 as the black market shadow exchange rate gave a foreign exchange premium of about 22 percent.

d) Shadow Price Selected

There is some variation in the foreign exchange premium figure from the three sources consulted. The average of the three figures is about 21 percent. In this study, a rate of 20 percent was used.

4. EVALUATION CALCULATIONS

As noted earlier in Section 1 of this Appendix, there were three principal objectives of the evaluations. Meeting each of these objectives required recombination of the same data several times for each project and was handled using computerised methods.

In Section 2, net present value was identified as the basis adopted for comparison using a discount rate of 15 percent. For private sector evaluation this was applied to project cash flow after tax and interest, i.e. without deducting depreciation. For economic evaluation this was applied to project expenditures and benefit flows, suitably weighted for foreign exchange content. Evaluation was conducted over ten years.

The data table used and details of the evaluation calculations involved are described hereunder.

4.1 Data for Each Project

4.1.1 Name of Company

4.1.2 Project Description

4.1.3 Capital Costs

These excluded duty and taxes expected by year over 10 years. They included any replacements which might be necessary over time and which had not been included in maintenance and operating costs. Direct foreign exchange components of capital costs were tabulated separately. Where particular items were expected to rise in price at a rate markedly different from the general rate of inflation, then the effect of the difference in rates of price inflation was taken into account, otherwise price inflation was omitted. Data tables gave:-

(a) Direct foreign exchange component of capital expenditure by year over ten years together with duty and sales tax;

(b) Domestic component of capital expenditure by year over ten years;

(c) Total capital expenditure by year over ten years.

4.1.4 Operating Costs

Expected changes in non-fuel operating and maintenance costs were given year by year over 10 years. Depreciation and interest were excluded and the domestic component separated from the imported component. Labour costs were not specifically separated.

4.1.5 Fuel Consumption

The expected change in fuel consumption (quantities) by fuel type was incorporated by year over ten years. It was possible to test the effect of different fuel prices on the NPV of fuel savings without having to recalculate capital and operating costs.

4.1.6 Transport

Transport and handling components are included in fuel prices.

4.1.7 Results

The results were presented in summary form in each Audit Report; and drawn on as a basis for project assessments in Volume 1 of this Report.

APPENDIX G

BIOMASS AND WOOD FIRING TECHNOLOGY REVIEW

APPENDIX G - BIOMASS AND WOOD FIRING TECHNOLOGY REVIEW

1. INTRODUCTION

The present method of wood firing in KTDA factories is to use billets of wood, usually 0.25 - 1.0m long, with hand firing into a furnace operating under suction from an induced draft fan. This method is inherently inefficient due to the following factors:

- Split wood billets are only able to release heat as a function of the surface area which is at the correct temperature and is in contact with oxygen. Because of physical configuration problems, shielding of various parts of the surface occurs and the radiant heat of the fire is non-uniformly distributed. Also, aerodynamic flows usually are stratified and the partial pressure of oxygen in the vicinity of any particular segment of the billet surface is unpredictable and variable.

- Because of the non-uniformity of the firing conditions, the usual practice is to increase the excess air passing through the manually stoked wood billet fired furnace with a consequent loss of efficiency.

- Uniform firing rates at the desired levels are difficult to establish. There is a "stop/go" effect where thermal inertia is raised to a high level by heavy stoking followed by a period of slow decline of the furnace heat release rate.

- For safety reasons the hand stoked furnace must be maintained at a high negative level of furnace suction pressure, thus increasing the intake of cold air which adversely affects efficient operation of the boiler or air heater ("Hewa Abiria").

- Manual stoking necessitates continual and repeated interruption of steady state draught conditions in the furnace due to the necessity to open the fire door at various intervals.

Following the historical progression of various firing methods with solid fuels, wood firing is now being achieved more efficiently by preparing the fuel into smaller particle sizes before it enters the combustion chamber where it is burnt in suspension. The reasons for this are given below:

- The surface area of the fuel is greatly increased.

- Combustion air and fuel are thoroughly and intimately mixed.

- Fuel can be fed without disturbing combustion air flow.

- Fuel can be obtained from much lower quality wood, and even biomass residues, so relieving user pressure on a premium resource.

- Firing conditions are steadier, requiring less excess air and giving a more even heat supply.

- The negative furnace pressure can be reduced, which will reduce "Hewa Abiria".

- Safety is improved.

2. PRINCIPLES OF SUSPENSION FIRING

The basic combustion relationship for a particle of fuel being fired in suspension is shown in Figure G-1.

The particles shown could be an oil droplet or a particle of wood or coal or some other solid fuel.

The main reason that oil has been so popular for suspension firing is that it is relatively easy to achieve the required combustion conditions shown in Figure G-1. However, wood is a superior fuel.

In its dry ash free condition, wood contains 44% oxygen (daf composition: C 50%; H 6%; O 44%) whereas oil only contains about 1% oxygen (daf composition C 84%; H 12%; O 1%; N 1%; S 2%).

This means that less air has to be supplied to fire wood in suspension and the opportunity formore efficient combustion is always present. Less air means higher adiabatic flame temperatures which can be controlled down to the optimum level of 1100 C 100 C.

The draught plant capacities are also reduced because, when compared with coal for example, wood already contains part of the oxygen required for combustion.

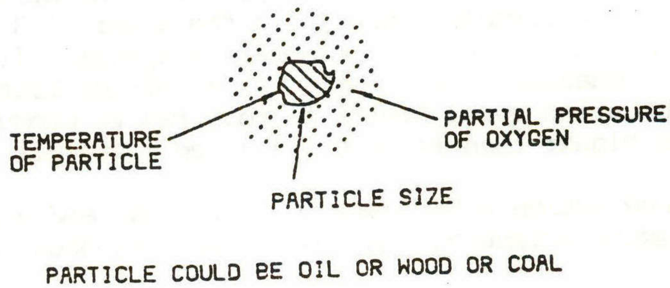
Biomass such as wood waste, rice husks, coffee husks, bagasse from sugar cane, etc., all possess remarkably similar chemical compositions. Therefore, the remarks that have been made concerning wood apply equally to these other biomass wastes which are found in Kenya.

The firing of such cellulose material in a cyclonic combustor is basically pulverised fuel/suspension firing under intense, controlled conditions.

Heat transfer from the products of combustion and the furnace walls rapidly drives off moisture and volatiles and pyrolises the fuel particles to a char.

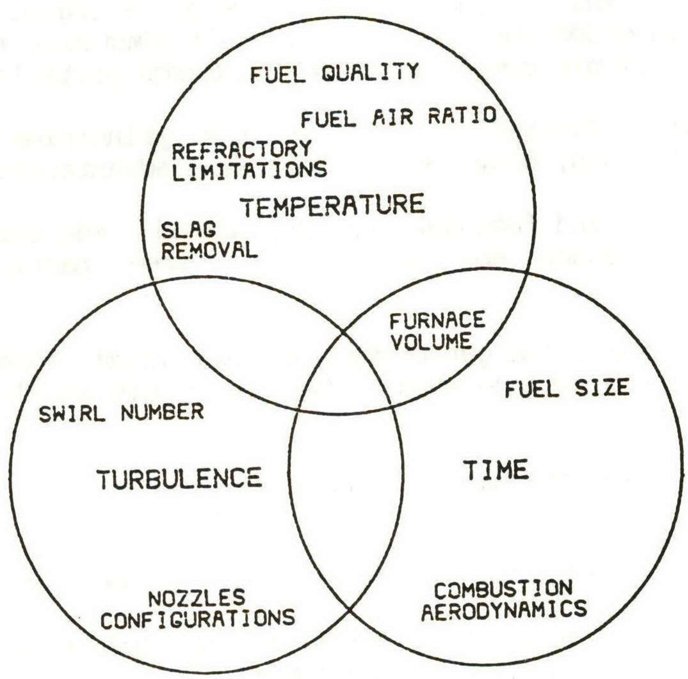
Therefore, it is char burning, rather than volatile evolution, that has the major effect on the size of furnace required. The rate of char burning depends strongly on the temperature of the particle and the partial pressure of oxygen in the gas surrounding it.

Results from tests at the International Flame Research Foundation during the late 1960s have helped develop sound principles for cyclonic combustion design. The cyclonic combustor has an integrated combustion system independent of outside influences. Consequently, the three main parameters of time, temperature and turbulence can be optimised to any particular pulverised fuel. Figure G-2 shows the various related factors which require careful attention if a cyclonic combustor is to operate successfully.



BASIC COMBUSTION RELATIONSHIP FOR SUSPENSION FIRING

FIGURE G-1



FACTORS AFFECTING THE OPERATION OF CYCLONIC COMBUSTORS

FIGURE G-2

Successful operation implies:

- Stable combustion temperatures within given limits;
- Minimal unburnt deposits in the combustor or char carryover at the hot gas outlet;
- Reasonable refractory life;
- Efficient slag removal;
- Safe burner management.

Within the range of the fuel qualities nominated for any particular combustor, stable combustion temperatures are ensured by using sound fuel and combustion air rate control practices. The retention time in a cyclonic combustor is extremely short, in the order of 30 ms. This compares with approximately 2 secs in a modern suspension fired sugar mill boiler burning bagasse, i.e. only 1.5% of the latter. Close attention to the combustion aerodynamics is required to produce a swirl number several times higher than is usual in a top class oil burner.

The re-entrant cyclone action being used in Australia, and apparently a world first, gives extra retention time in the same furnace volume and length.

A high velocity mixture of fuel and air skims around the periphery of the furnace as it moves towards the ignition zone at the rear. This allows the flame, which is proceeding by cyclonic action down the axis, to dry incoming fuel by direct radiation.

Figure G-3 shows the configuration and design constraints for biomass direct fired plant. This illustration compares a travelling grate water tube boiler intended for wood approximately 50mm size fired on a moving grate and a cyclonic combustor using 70 micron particles.

The cyclonic combustor faithfully fulfills the principles outlined above and, because it does, provides the following advantages:

- Combustion air and fuel get very well mixed; the burning only takes little space and most of the wood particles burn rapidly.

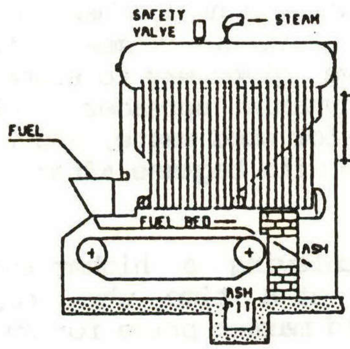
- Large wood particles get pressed by centrifugal force against the wall of the cyclone where they move more slowly and burn out completely.

- Combustion gases are clean.

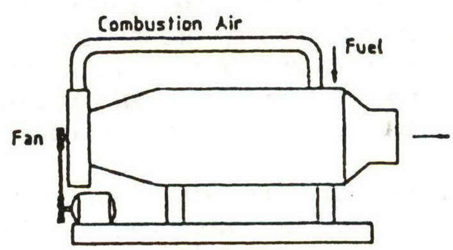
- The refractory lined cyclone cools slowly so that firing, even after a long break, can be started again without problem.

Both types of equipment have long standing commercial operational experience and this background is now described.

1. Typical arrangement



(a) Travelling grate water-tube boiler



(b) Cyclonic combustor

2. Design constraints

Gross calorific value
(wood (dry ash free) - 20.4 GJ/tonne
(bagasse (" " ") - 19.4 GJ/tonne
(rice husks (" " ") - GJ/tonne
(municipal shredded waste
(M.S.W.)-30% water 8% ash) - GJ/tonne

Adiabatic flame temperature - e.g. wood (d.a.f.) - 2200°C

Combustion times in furnace (typical)
(wood, 50mm size, 30% water, inclined grate
(- 15 minutes
(wood, 70 μm size, 10% water, cyclonic combustor
(- 30mSec.
(bagasse as milled, 50% water, suspension fired
(- 2 sec.

3. Typical performance data

Sawdust
37.5 t/h sawdust @ 8000kJ/kg
30 GJ drier

Bagasse
100 t/h bagasse @ 10 000kJ/kg
steam conditions 2500 kPa, 320°C
200 000 kg/h of steam to process
14MW of power for export.

4. Commercial standing

Long standing commercial operation.

CONFIGURATIONS & DESIGN CONSTRAINTS FOR BIOMASS DIRECT FIRED PLANT

FIGURE G-3

3. OPERATIONAL EXPERIENCE

The historical development of biomass combustion for industrial purposes really covers a period of some 100 years. Perhaps the sugar milling industry represents the most consistent example of the progression in technology and procedures since they have always used the waste from crushed sugar cane, i.e., bagasse. In early times, some 60 years ago or longer, pile grate furnaces were in use. Then inclined and moving grate furnaces were used with long retention times up to say 15 minutes, and since the 1960s these have given way to suspension fired equipment using mechanical and aerodynamic spreader stokers. Also, cyclonic combustors have been used for wood waste, and trials have been made recently in Australia for use with bagasse after it has been dried to an acceptable moisture level.

The latter trials are directed towards achieving a higher thermal efficiency from an existing boiler plant at a time when capital expenditure is restricted due to the low world market price for sugar.

Other special furnaces are available for biomass, such as gasifiers and the fluidised bed combustor.

Probably the most prominent international examples of suspension firing of wood waste are found in Sweden, Canada and Germany. The preparation of the fuel into fine particles and its drying, using waste heat from boiler flue gases and/or other process equipment, and then the suspension firing in a high swirl combustor is characteristic of the technology which has been in use in these countries for some 15-20 years. In fact, one Swedish company markets an integrated set of fuel preparation/drying equipment intended for supplying fuel to the burner.

Actually, cyclonic type combustors were in use in the early 1950s when coal fired cyclone furnaces were developed to overcome problems encountered with pulverised fuel coal firing. These units provided valuable experience, but the size of utility boilers increased so dramatically that the furnace technology reverted to swirl burners directly firing pulverised fuel through the furnace wall.

The Australian developments in the timber industry during the 1970s resulted in the construction of two 30 GJ/h units to fire sander dust and sawdust. These units are still employed after several years of successful service for the drying of wood flake (Ref. 12.4).

Another well publicised American cyclone burner is the Energex unit which is described in a paper presented to the Kenya Tea Development Authority - Conservation Seminar on 12 April 1985 (Ref. 12.2).

Several prominent industrial organisations in Australia are fully committed to the use of biomass instead of more expensive fossil fuels. They include Australian Newsprint, Nestles, Softwood Holdings, CSR/Pyneboard and Rice Growers Co-operative at Griffith, NSW. Also, as an example of a developing country making use of this technology, Fiji has several wood fired boilers in commercial operation in addition to its long established bagasse fired sugar mill boilers.

The virtual absence of sulphur or other noxious chemicals makes biomass fuel environmentally attractive and correct combustion practices will invariably produce low emission levels.

The wood waste direct fired boiler or air heater installation in a KTDA factory would have the following features:

- Adequate fuel preparation and storage equipment. Fuel should be finely milled and less than 20% mcwb for good results. Figure G-4 indicates methods for preparing fuel.

- Operation by trained attendants.

- A quiet operation with smooth adjustment of heat output to match the demand.

- High thermal efficiency, since the excess air level can be closely controlled and the flue gases from the boiler or air heater can be used in an efficient way to dry the fuel before firing.

- Good employment opportunities for fuel handlers and ash cleaners as well as for the trained operators.

- Rapid acess to backup spares and maintenance service knowledge, since the fuel preparation equipment which contains the most moving parts is operating at ambient temperature and is readily accessible.

- Flexible fuel options, since a variety of biomass can be passed through the drying/pulverising equipment to provide particle fuel suitable for suspension firing in the cyclonic combustor.

4. COMMERCIALLY AVAILABLE EQUIPMENT

The extent of the commercial availability of equipment for the industrial use of biomass is well illustrated by the directory compiled by Todd & Elliffe (Ref. 12.7 - "Todd, J.J. and Elliffe, M.D.: Directory of Equipment for Industrial Use of Crop and Forest Residue Fuels (1983)" - Centre for Environmental Studies, University of Tasmania, Australia.

This directory lists 8 headings, namely:

Harvesting equipment - field chippers, stump harvesters, etc.
Handling equipment - fuel trailers, conveying systems, reclaimers, etc.
Storage equipment - silos, bins, etc.
Fuel preparation equipment - debarkers, chippers, shredders, hammer mills, etc.
Combustion equipment - grate, suspension, solid fuel stokers, etc.
Cogeneration equipment
Pollution control equipment
Instumentation and control equipment - fuel flow measuring, combustion control, metal detection and removal systems, etc.

This directory gives the names of 400 organisations involved in supplying the equipment listed.

In the case of KTDA factories, it is noticeable that the maximum continuous rating required for a cyclonic combustor conversion of air heaters or steam boilers would require combustor ratings of around 6 GJ/h heat release in fuel to 12-15 GJ/h for the largest boilers seen during the audits. Typical dimensions of cyclonic combustors are shown in Table G.1.

TABLE G.1 - TYPICAL DIMENSIONS OF CYCLONIC COMBUSTORS

Fuel size	microns	700 x 1200					
Fuel GCV	kJ/kg	19000					
Fuel moisture	% wb	8					
Heat output	GJ/h	2	5	10	20	30	40
Fuel rate	kg/h	110	270	530	1050	1580	2100
Combustion external dia.	mm	800	1000	1200	1400	1600	1700
Combustor external length	mm	1300	1700	2100	2600	2900	3200
Assembly length	mm	2400	3300	4200	5200	6000	6600
Assembly width	mm	1000	1500	1800	2300	2500	2800
Assembly height*	mm	1500	2000	2500	3000	3500	3800
Assembly weight	tonnes	5	8	10	12	14	16

* Height shown is for a moveable unit on rails.

The above ratings are relatively small by industrial standards, but they do lead to economies in capital cost since the equipment involved is quite small and the fuel rates correspondingly low.

The importance of efficient use of biomass in Kenya means that some foresight is needed in equipment selection so that the highest efficiency is provided with a view to the future since it is anticipated that the biomass resources in the 1990s will need to be treated even more carefully than now.

The various options available at KTDA factories are numerous and interesting. A brief description of a typical KTDA conversion is described in Section 5 hereunder.

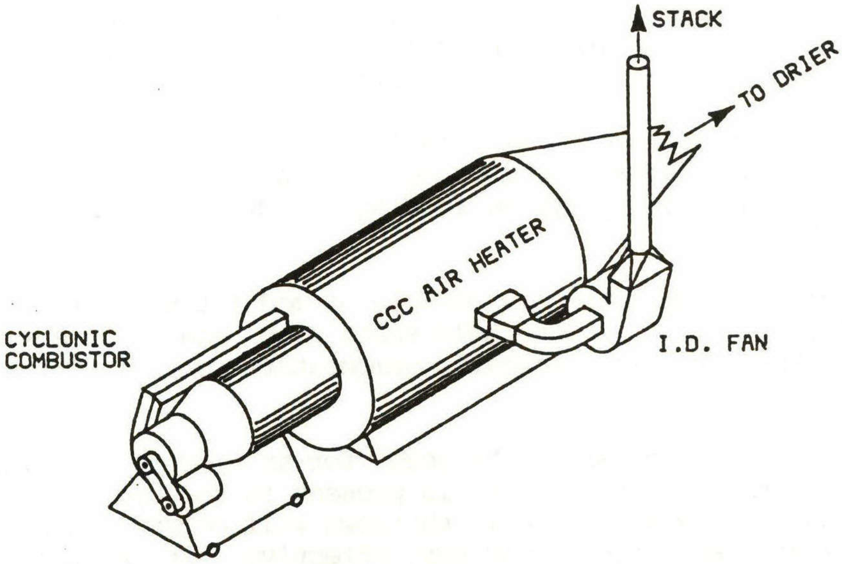
5. TYPICAL KTDA CONVERSION - CCC AIR HEATER

The Colombo Commercial Company cylindrical air heater with its dryer air jacket and spacious combustion chambers lends itself readily to conversion from oil to wood waste firing.

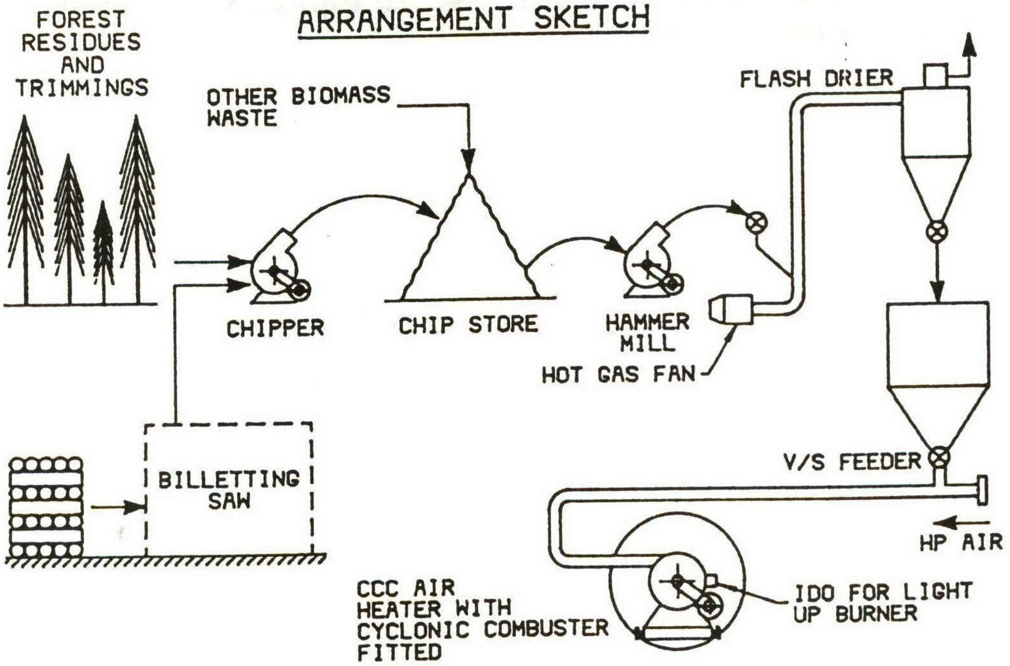
Figure G-4 shows a sketch of a typical arrangement after conversion and also a flow diagram nominating the main components of the fuel preparation and drying system feeding the cyclonic combustor mounted on the air heater.

The cyclonic combustor is capable of modulating over a range of at least 4 to 1 whilst in the self-sustaining mode, and advantage can be taken of this by using automatic temperature control of the dryer inlet air temperature.

Attention is also drawn to the need for an electronic flicker detector to ensure that a stable flame is present in the cyclonic combustor at all times, otherwise automatic shutdown will occur. This precaution in the design has been found very effective in Australia where no untoward occurrences have arisen due to explosive wood dust mixtures being ignited accidentally.



ARRANGEMENT SKETCH



NOTE: NO.1 FEEDER IS DEDICATED TO NO.1 AIR HEATER.
OTHER AIR HEATER USE INDEPENDANT V/S FEEDERS & FUEL LINES.

FLOW DIAGRAM

COLOMBO COMMERCIAL COMPANY
AIR HEATER CONVERTED TO WOOD
FIRING WITH A CYCLONIC COMBUSTOR

FIGURE G-4

APPENDIX H

OIL FIRING TECHNOLOGY REVIEW

APPENDIX H - OIL FIRING TECHNOLOGY REVIEW

1. INTRODUCTION

The use of oil as a fuel has a history extending back over 80 years. However, it is only in the last 20-30 years that burner manufacturers have achieved oil combustion performance to match the needs of industrial users burning an expensive fuel.

Modern industrial applications of oil burners require:-

- High burner thermal conversion efficiency with low excess air.
- Stable flame behaviour without loss of unburnt oil from the flame zone. As well as causing serious loss of efficiency, unburnt particles of fuel foul heat transfer surfaces and cause environmental problems and boiler back end acid corrosion.
- An ability to accept reasonable variations in fuel viscosity and quality.
- Robust construction with control adjustments and safe burner management systems which are within the capacity of the normal industrial maintenance team.

The developments in technology which now make these features available at a reasonable cost are described below, after a summary of the principles of oil firing.

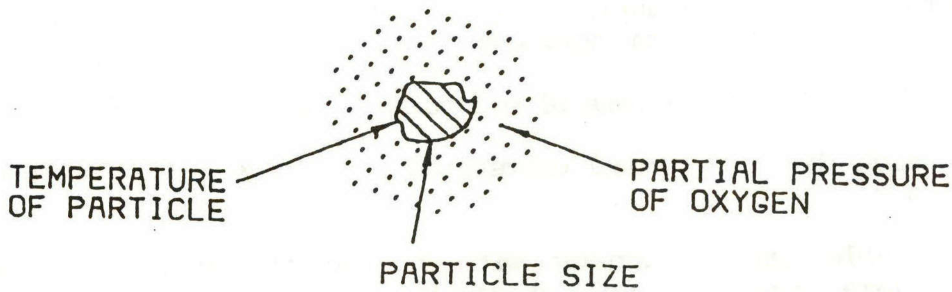
2. PRINCIPLES OF OIL FIRING

The three fundamental factors which control the proper combustion of oil are:

1. The burner must supply the fuel in a readily combustible form.
2. The air required for combustion must be supplied in the right quantity and intimately mixed with the fuel as soon as possible in the furnace.
3. The total combustion of the fuel must be completed within a predetermined volume which is dependent on the furnace dimensions. This avoids impingement on heat transfer surfaces and refractories.

Oil firing is another form of suspension firing as illustrated in Figure H-1.

FIGURE H-1 - BASIC COMBUSTION RELATIONSHIP FOR SUSPENSION FIRING



PARTICLE COULD BE OIL OR WOOD OR COAL

Combustion of oil is a rapid chemical combination of oxygen with the combustible elements resulting in the release of heat. Air consists of approximately 23% oxygen and 77% nitrogen and the composition of oil on a dry ash free basis is:

Carbon	84%
Hydrogen	12%
Oxygen	1%
Nitrogen	1%
Sulphur	2%

The reaction is:

$C + O = CO$ + 32,710 kJ for each kg of carbon.

$2H + O = 2H\ O$ + 141,813 kJ for each kg of hydrogen.

$S + O = SO$ + 9,242 kJ for each kg of sulphur.

Sulphur is of minor significance as a heat source, but is also the major cause of both corrosion and pollution problems.

Perfect combustion, or stoichiometric combustion, is the result of mixing and burning exactly the right proportions of oil and oxygen so that there are no constituents left over. A fuel oil with a gross specific energy (GSE) of 42.9 GJ/t has a stoichiometric air requirement of 13.9 kg/kg of oil. Normal industrial oil burners could be expected to be operating in a range of 15-25% excess air, i.e. 1.15 - 1.25 times the stoichiometric air-fuel ratio.

If too much oxygen is supplied, the mixture is called "lean" and the fire is oxidising. The resulting flame tends to be shorter and clearer. The excess oxygen and all of the nitrogen with it take no part in the combustion process and escape as excess air through the stack, carrying with it some of the heat of combustion.

If too much fuel is supplied, the mixture is called "rich" and the fire is reducing. The resulting flame tends to be longer and smokey. The fuel particles cannot all combine with the available oxygen, and incomplete combustion occurs. Incomplete combustion can also occur under "lean" conditions when poor combustion or inadequate swirl are present in an inferior burner.

It is vital for complete combustion that all the fuel and air leaving the burner are mixed thoroughly so that the mixture is uniform throughout and every particle of fuel is contacted by a particle of air. It is the function of the burner to break up the fuel into small particles and to inject these fuel particles into the air stream.

A flame is an envelope or zone within which the combustion reaction is taking place. In a stable burner flame, the flame front appears to be stationary because the flame is moving towards the burner at the same speed that the fuel-air mixture is leaving the burner. For a proper mixture, the oil and air streams must also have the proper velocity with respect to each other.

If the fuel-air mixture is fed from the burner too fast, the flame will blow off; but if fed too slow, the flame may flash back into the burner.

Thus in summary, the three important requirements for good combustion are:

1. A <u>temperature</u> which is high enough to ignite the combustibles.

2. Sufficient <u>turbulence</u> to ensure a thorough mixing of the fuel and air particles.

3. Adequate <u>time</u> to complete the combustion process.

These three factors are commonly referred to as the "Triple T" law of combustion:

- Temperature
- Turbulence
- Time

3. OIL BURNER TYPES

Three basic types of oil burner are in common use:

- Mechanical or pressure atomising burners.
- Steam atomising burners.
- Air atomising burners.

3.1 Mechanical (Pressure) Atomising Burners

In this burner the oil is raised to the pressure required for atomising by means of a high pressure pump usually associated with a pumping and heating system. In its simplest form oil passes through a spray nozzle which usually contains a number of tangential passages through which the oil passes towards the central chamber. In this chamber high volocity swirl is imparted which is released through the orifice in the form of a conical mist.

The pressure atomising burner in smaller sizes and for smaller boiler units has an operating pressure of 1400-2100 kPa (14-21 bar). In oil prssure atomising burners, oil viscosities of 80-110 sec Redwood No. 1 are required at the burner. This will mean oil temperatures in the range of 60 deg. C for 200 sec oil to 116 deg. C for the heavier Bunker C oil.

Another type of mechanical atomising burner is the rotary cup. A mechanically driven cup receives oil at low pressure which spins off in a partially atomised form at the lip of the cup. Here, high pressure primary air commences the fuel air mixing which is completed by secondary air at lower pressure. This type of burner is notorious for long flames and suspect atomisation if the oil quality is poor.

Pressure atomising burners can also suffer from the wrong application where the oil quality is below specification and the fuel-air mixing and the retention time in the flame zone are inadequate to prevent the escape of unburnt oil due to initial poor atomisation of the inferior fuel.

3.2 Steam Atomising Burners

The difficulty of limitation in range of the pressure atomising burner is largely overcome in the steam atomising burner in which a turndown ratio of 10:1 is possible. Steam at a pressure of 140-850 kPa is fed through the central burner tube to a perforated nozzle where it meets the oil which is passed along an annular space between the central steam tube and the concentric outer tube. The initial oil temperature need not be as high as the pressure atomising type since additional heat is imparted to the oil during its passage down the central tube.

The steam atomising burner produces a particularly fine spray and, for this reason, is tolerant of variations in oil fuel quality and gives very efficient operation with low excess air. Steam consumption is around one half to one percent of boiler steam output. An equivalent amount would apply, say, to an oil fired air heater.

3.3 Air Atomising Burner

This burner, in which atomising is carried out by high pressure air in a similar manner to the steam atomised burner, is very useful where an air heater or fired process heater is operating without any steam on the premises. The atomisation produced is somewhat superior to steam atomisation. It enables very efficient operation without unburnt particles of fuel causing acid corrosion, loss of effficiency, or environmental problems when operating with low excess air.

4. ATOMISATION

The combustion of sprays is a complex process which involves simultaneous heat, mass and momentum transfer and chemical reaction. The chief factors affecting the combustion of spray droplets are :

- Drop size.
- Composition of the fuel.
- Ambient gas composition, temperature and pressure.
- The relative velocity between the droplet and the surrounding gas.

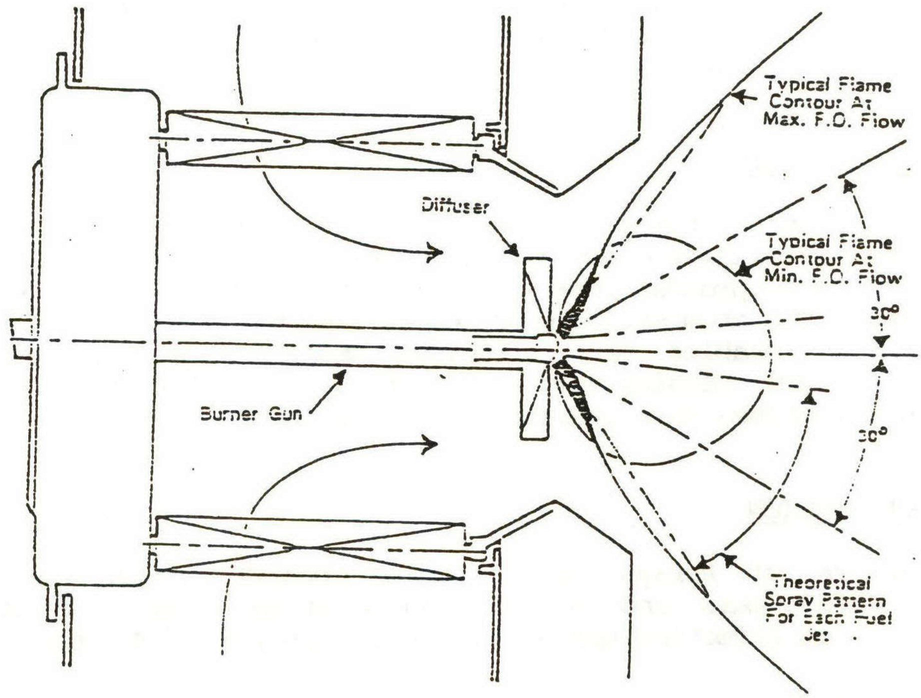
The main aspects requiring operator attention are the achievement and maintenance of an adequate atomisation efficiency during the service life of the burner. Some very basic designs of atomising nozzles are to be found in modern oil burners, especially in sizes 15 GJ/h or less, and this aspect requires caution when eqipment is specified and purchased. The apparent initial cost saving will be overtaken many times over the burner's lifetime by increased maintenance and increased oil consumption.

Regardless of the initial oil specification, a tolerance to variations in oil fuel quality is essential since historically all oil refineries are reluctant to hold to any degree of accuracy in meeting specifications.

In many cases it may be necessary to convert from pressure atomised nozzles to steam or air atomised burners, or "guns" to cope with the variable quality of fuel delivered.

Figure H-2 shows a typical oil flame pattern. It will be seen how it varies from minimum fuel oil flow to maximum fuel oil flow. In the illustration swirl is provided not only by the diffuser at the end of the gun but also by vanes where air enters the burner from the windbox. The burner shown is a register type burner.

FIGURE H-2 - TYPICAL OIL FLAME PATTERN



It is possible to check the behaviour of an oil firing gun and its nozzle by supplying it with high pressure water in the open, using a test rig and a pressure gauge. The high pressure water is often obtained from the boiler feed pump using a small test line. This test should be done when the burner nozzles are new and then later after being subjected to service wear. It is not generally known that oil erodes the diameter and shape of apertures in an oil firing nozzle as service life progresses.

If the oil droplets are too large or there is a non-uniform mixture of small and large droplets in the flame zone, the large drops will lose their lighter fractions which will vaporise readily, and what is left is known as a "cenosphere".

The cenosphere is actually a spherical carbon particle which is extremely difficult to ignite and burn once it reaches the edge of the flame zone and, if it leaves the flame zone, then it is carried on as unburnt fuel depositing on heat transfer surfaces and appearing as smoke at the stack.

Many cases of inefficient operation of industrial oil burners can be traced to this source since the maintenance team tend to increase the excess air level in an attempt to mix these "cenospheres" with the active flame as much as possible and avoid them, leaving the surface unburnt. The real reason for the problem is poor atomisation.

Attention to this aspect will bring substantial rewards and ease of adjustment of air-fuel ratios, stable flame behaviour and the ability to operate at the correct air-fuel ratios to give energy efficient conditions and reduce fuel costs.

5. SWIRL AND FLAME SHAPE

The air entering a burner will produce long flames with poor mixing charactertistics unless it has adequate swirl. This aspect of oil firing has been dealt with extensively by tests and calculation, and it has been found that the swirl number of any particular burner can be very important if efficient firing is to be obtained.

The swirl number is basically a non-dimensional ratio of the radial (or circular) momentum divided by the axial momentum.

Not only does swirl produce good mixing of the oil droplets as they leave the gun, but the swirl produces recirculation of hot gases inside the flame zone itself, thus providing more ready igniton of the incoming cold fuel and allowing combustion to be completed within the flame zone.

By having these desirable features in the flame, the flame shape can be established in a stable manner and also within a given length and volume. This can be important in achieving the correct relationship between the oil burner and the furnace configuration to which it is applied.

It is not often realised that an oil burner operating in a refractory lined chamber may behave quite differently if it is surrounded by relatively cold metal which does not reflect heat back on the flames and, in fact, acts as a heat sink absorbing considerable amounts of heat from the flame and quenching the flame tips wherever they come within close proximity of the metal. Influences such as these, which tend to reduce temperatures in the flame zone, can be extremely disadvantageous, especially if atomisation is poor.

Generally speaking, the small diffuser fitted at the outlet of package burners is suspect. Register type burners, where the air enters from a windbox completely surrounding the burner proper, will be found to give superior swirl behaviour. Ironically, many older type burners were designed in the latter fashion and give superior performance to the more modern integral burner assemblies supplied and fitted today.

6. OIL FUEL PROPERTIES

The properties of oil fuel are typically as follows:

Specific gravity at 15.6 deg. C	0.965
Gross specific energy	43.5 GJ
Carbon content	87%
Hydrogen	11.5%
Sulphur	2.5%
Ash	0.08%
Flashpoint	66 deg. C
Water and sediment	2%
Viscosity Saybolt Universal seconds at 37.8 deg. C	9,000 max. 900 min.
Kinematic viscosity centistokes at 50 deg. C	648 max. 92 min.
Pour point	+ 17 deg. C

The most important factor for energy efficiency is the viscosity at the moment the oil is fired by the burner. Burner nozzles are designed for a specific viscosity and any variation will result in poor performance of the burner, especially if the nozzles are of a pressure atomising type. Correct oil viscosity is reached by preheating the oil, and therefore it is a basic prerequisite to know the design viscosity of a burner and the correct level of preheat needed to maintain this viscosity. If the preheat is too high, the viscosity will be too low and, in most cases, the feed rate will be too high. The flame will be noisy and unstable, and the cone can collapse.

If the preheat is too low, the viscosity will be too high and the feed rate in most cases will be too low. The droplet size will be too large, causing incomplete combustion and soot. Industrial type burners are usually designed to atomise if the oil is brought to a viscosity of 30-45 centistokes. The table given below indicates the amount of preheat recommended by the oil manufacturers. In each specific factory it is recommended that the supplier be asked for a viscosity-temperature curve in any case.

TABLE H.1 - PREHEAT REQUIRED TO OBTAIN 30-45 CENTISTOKES VISCOSITY AT THE BURNER

Specification Viscosity at 38 C		Temperature in Degrees Centrigrade Required to Obtain 30 Centistokes	45 Centistokes
Centistokes	Redwood 1 seconds	C	C
740	2500	96	85
1000	4000	102	93
1600	7500	110	102

Circumstances arise occasionally where a boiler has to be started cold. The limit would be at about fuel viscosity 20,000 seconds Saybolt Universal at the pump suction.

With 3600 Redwood fuel, the operator would be able to do this, even if the temperature of the oil fell to 16 deg. C. With 7500 Redwood, difficulty could be experience if the oil went below 27 deg. C and that could happen, even in tropical countries if the boiler is shut down for a lengthy period. The problem would not occur too often, and there are ways of coping with it, the simplest being to have a small quantitiy of some lighter or lower viscosity fuel, such as diesel oil, for start up.

7. AUTOMATIC CONTROL SYSTEMS

There are two automatic control systems normally associated with a modern industrial oil burner. These are:

- The burner management system with specific interlocks for flame detection, oil temperature, purge time, etc. to ensure the safety of the boiler and the associated plant in accordance with the statutory codes.

- The automatic firing rate and combustion controls.

Burner management systems are well developed products. Provided a reliable self-checking flame detector and solid state electronics of good design are used, there should be minimal operations problems.

The automatic combustion control system, from an energy point of view has the most important task of controlling the air-fuel ratio at all times and over the full firing range within the turndown ratio.

Unfortunately, it does not matter how good is the automatic control system if the fundamental burner properties are inadequate. With poor atomisation, and inadequate swirl, the system will operate inefficiently regardless of the control system.

In small to medium size installations it will be found that some form of mechanical coupling between the oil modulating valve and the forced draught (FD) damper is employed, although there is an increasing tendency towards separate cam characterised pneumatic or electric actuators for these functions. These enable fine adjustments to be made to ensure the best combustion efficiency over the whole firing range.

The advent of the zirconium oxide oxygen analyser has meant that the rather simple burner control arrangement described above can be modulated to a specific oxygen level at the flue gas outlet from the boiler or furnace. In some simple mechanically coupled systems one of the mechanical links contains an automatically extendable component which adjusts the air-fuel ratio in accordance with the measured oxygen level. Larger systems usually employ fuel metering and cross limiting, and this extremely good arrangement can then be complemented with oxygen trim.

8. APPLICATION ENGINEERING

The successful application of oil burners sold "off the shelf" as pre-packaged units is more involved than generally realised. Often, a perfectly good burner designed for a refractory lined furnace can perform very poorly in the metal lined furnace chamber of a fire tube boiler.

Factors such as flame length, furnace volume, furnace diameter and the level of efficiency required have not been given sufficient attention. Also, the vagaries of varying fuel quantities are sometimes not realised at the design stage.

It is important that the specification for any particular oil firing installation be given thorough engineering design attention and related specifically to the application before quotations are called. Modern burner manufacturers throughout the world have considerable capabilities at their disposal, but do not necessarily provide these unless the purchaser insists that he requires certain levels of performance to achieve a sustained high energy efficiency and reliability over the lifetime of the combustion system as a whole.

APPENDIX I

OPERATION AND MAINTENANCE OF STEAM SYSTEMS

APPENDIX I - OPERATION AND MAINTENANCE OF STEAM SYSTEMS

1. BOILERS

To minimise fuel consumption, whether oil, wood or any other fuel, steam raising boilers must be operated and maintained to run at maximum efficiency at all times. This is achieved by giving proper attention to each of the matters listed below:

i) Heat Transfer Surfaces

Regular cleaning of fire side heat transfer surfaces is most important. Dirt will reduce heat transfer from the products of combustion to the boiler water, and the 'unused' heat will simply be lost in the flue gas. It is recommended that a stack thermometer for flue gas be installed to assess the condition of the heat transfer surface at any time. Flue gas temperatures should normally lie between 160 deg. C and 200 deg. C. At higher temperatures useful heat is needlessly wasted. Below 160 deg. C dew point condensation can take place. The condensate absorbs the sulphur dioxide in the flue gas to form sulphurous acid. This can result in back end corrosion of the boilers and/or corrosion of the chimney.

Losses of up to 6%, or more in extreme cases, can occur if heat transfer surfaces are dirty.

ii) Combustion Performance

The type of fuel and method of firing a boiler have received increasing attention as fuel price penalties have risen. Detailed comments on this aspect are given in Appendices G - Biomass and Wood Firing Technology Review and H - Oil Firing Technology Review. They apply to boilers and fired air-heaters.

iii) Boiler Feed

Controlled boiler feed water treatment is essential to prevent the formation of scale build-up, corrosion, foaming and carryover, all of which lead to water side heat exchange surface fouling, and hence excessive fuel consumption and possibly plant damage. Boiler water treatment must be as recommended by a water treatment specialist and be carefully maintained by the boiler attendant through daily checks. Treatment levels below those recommended will not achieve the protection required, while over-dosing is needlessly costly.

Fuel loss through scale build-up is approximately as follows:-

0.75 mm thick scale will result in 8% fuel loss.
1.5 mm thick scale will result in 14% fuel loss.
3.0 mm thick scale will result in 20% fuel loss.
6.0 mm thick scale will result in 50% fuel loss.

iv) Total Dissolved Solids (TDS)

Control of TDS in boiler water is most important and is maintained through boiler blowdown. Blowdown is also essential to clear accumulated boiler sludge and suspended solids (TSS). TDS in packaged boilers must be maintained between 1000 to 2000 ppm or as recommended by the water treatment specialist. TDS should be monitored at each shift by the boiler attendant. Blowdown rates that are too low will fail to limit TDS to acceptable levels and hence lead to scaling, while too much blowdown will needlessly waste fuel, water and treatment chemicals. Higher than recommended TDS can lead to production of wet steam through water carryover. Steam wetness can increase from about 5% to around 35% if TDS levels increase from 2000 to 3000 ppm and foaming occurs.

v) Fuel Oil Heating

Fuel oil heating should be arranged with controls to maintain the correct fuel temperature and hence minimum use of energy for heating. The correct oil temperature and pressure, and hence viscosity, also have an important bearing on the atomising performance of an oil burner (Refer Appendix H).

vi) Boiler Feed Tanks

Boiler feed tank design should incorporate the following features:-

- Minimum one hour evaporation at maximum continuous rating (MCR)
- Condensate return through a sparge pipe fitted with an antisiphon check valve.
- Bolted manhole for inspection and cleaning.
- Vent pipe.
- Adequately sized ball valve for make up water.
- Feed pump suction oulet at minimum of 100 mm above tank bottom.
- Drain outlet.
- Overflow with water seal.

vii) Condensate Tanks

The condensate tank must be insulated to reduce heat losses, and installed at a height sufficient to avoid feed pump cavitation at the maximum condensate temperature. Typically, this will be about 3m above the pump suction.

viii) Working Pressure

Boilers must be operated at their design working pressure and neither significantly above nor below it. Lower pressure operation leads to generation of wet steam and priming. Higher pressure operation wastes energy and can lead to unwanted safety valve operation.

ix) Blowdown Heat Recovery

Heat recovery from boiler blowdown can be considered if blowdown rates are necesarily high.

2. STEAM DISTRIUBTION

Saturated steam should be distributed with minimum loss of heat, minimum pressure drop and at a velocity not exceeding 25 m/s. A higher velocity is generally economic for superheated steam where there is no risk of condensation and associated water hammer. The distribution system should ideally include drain trap sets and air vents and have an adequate slope in the direction of flow to ensure removal of condensate and air. It is usually economical to distribute steam at boiler working pressure with the pressure reduction, if required, immediately ahead of the user equipment.

3. STEAM SYSTEM LOSSES

Losses in steam system are due to:

i) Poor Insulation

A minimum insulating efficiency of 90% is desirable. To achieve this, all pipework, fittings, flanges, valve bodies and hot plant must be effectively insulated. One metre of 80mm uninsulated pipework carrying steam at 7 bar continuously can typically waste nearly 500 L/a of fuel oil.

ii) Leaks

Leaks must be made good as part of proper routine maintenance. One 3mm hole in a system at 7 bar can waste up to 9000 L/a of fuel oil.

iii) Moisture

Moisture in steam lines can result in unnecessarily high steam consumption due to reduced latent heat, reduction of steam space, cooling of incoming steam and filming of heat transfer surfaces. It can also result in water hammer, corosion or erosion, all of which can lead to damage of pipework, control valves, steam traps, and steam using plant. At worst it can lead to extensive damage. Moisture in steam can be minimised by correct boiler operation, correct deisgn of pipework, and correctly installed steam separators and drain traps. Traps should be installed typically at all system low points, sharp changes of direction and at terminal ends of pipework.

iv) Air

Air in steam leads to filming of heat transfer surfaces and reduced steam temperature, in turn leading to poor fuel efficiency. It can lead to corrosion and, in extreme cases to distortion of plant from uneven heating. A 0.025 mm air film has the same heat transfer resistance as a 330 mm thick copper plate.

v) Expansion

Provision must be made for pipework expansion by change in direction, cold drawing, expansion loops, bellows and anchor points as necessary.

4. STEAM UTILISATION

Steam supply to user plant should be dry, free of entrained air and at the lowest feasible pressure. Temperature controls should be incorporated where required for close process control. If the steam is wet, supplies to individual equipment items should preferably be through a steam separator. A correctly selected, sized and installed reducing valve or temperature control valve with a protective strainer upstream and a pressure gauge should be used if necessary. A correctly sized pop type safety valve is desirable for equipment protection on the downstream side.

Air vents should be provided on equipment to allow for air removal from steam spaces.

Steam traps for each duty should be carefully selected, correctly sized and correctly installed to ensure maximum system efficiency. Traps should be routinely checked for correct operation using a trap failure indicator. One 15mm leaking trap draining a system of 7 bar pressure can waste between 3 to 5 L/h of fuel oil (approximately 28 ML/a).

5. CONDENSATE RETURN

Condensate discharged from steam traps, while at much lower than boiler pressure, is normally nearly at initial steam temperature. Thus it still retains a considerable heat energy, some of which may be lost to atmosphere as flash steam from the vents of the boiler feed tank or the condensate receiver.

Flash steam can, however, be utilised for lower temperature processes, so increasing overall plant efficiency. Furthermore, condensate after removal of the residual heat in flash steam still contains useful heat and is distilled water. It is therefore ideal as boiler feed and should never be wasted. In a plant operating say 7000 h/a, each t/h of condensate returned will result in yearly savings of about:

42,000 L/a of fuel oil
7,200,000 L/a of water
KSh 50,000 worth of chemicals

Boiler feed tanks are usually situated at a higher level than system trap discharges, thus return condensate has to be lifted. This can be achieved by the steam operated Ogden pumping trap or by a centrifugal pump with a low net positive suction head (NPSH) to handle hot water.

Ideally, condensate from steam traps should be gravity discharged into a receiver for onward pumping to the boiler feed tank. Problems can be encountered if steam traps discharge against the positive pressure required to lift condensate direct to the feed tank. This is because:

- back pressure on the trap can result in reduced capacity which may not be acceptable, and
- water hammer may occur which will in due course damage the trap.

If the plant is temperature controlled, condensate must not be lifted against trap back pressure. The throttling effect may result in variation of steam pressure upstream of the trap, which in turn may lead to unsatisfactory control or to water hammer.

6. ACKNOWLEDGEMENT

Material for this Appendix was prepared on behalf of the Project Team by Mr Shaukat H Sangrar, Regional Engineer East Africa, Spirax - Sarco Limited, Narobi, Kenya.

APPENDIX J

J.1 TEA FACTORY AUDIT PROGRAMME

J.2 ENERGY SURVEY QUESTIONNAIRE

J.3 FACTORY OFFICERS' SEMINAR

APPENDIX J.1

TEA FACTORY AUDIT PROGRAMME

(a) **Audit Teams**

Team A - Energy analysis (Williams, Alles (p/t), Thomas (p/t) Mwake)
Team B - Energy analysis (Gilmour, Alles (p/t), Thomas (p/t) Magoha)
Team C - Forestry and biomass resources (Gray, Chanzu, Dept. Forestry)
Team D - Energy analysis (Kirkwood, Nicklin, Mwake)
Team E - Transport economics (Bishop, O'Malley, Bagha)

(b) **Approach to Audits**

The week 1 familiarisation visits were to enable the team to understand the particular energy problems facing the tea industry in Kenya, and to work as a team. During that week time permitted detailed development of the approach to auditing, suitability of the questionnaire, model audit form, etc.

Following the Factory Officers' Workshop on Monday 16 September 1985, at the commencement of week 2, the full scale audits started. The first four audits, for which the Teams A & B were based in Nairobi, were carried out by the teams jointly to ensure standardisation of audit techniques, and to permit each team to benefit from the others' experience and so pass it on during later audits. Calli Alles was available for these early audits.

The detailed programme for Team C on forestry was developed following discussions between Keith Gray and David Chanzu. The programme for Team C on forestry was developed following the arrival of Peter Bishop on 20 September 1985.

After completing all audits east of the Rift Valley Teams A and B returned to Nairobi on 24 September and 25 September respectively. This allowed time to assess results obtained to date on 25 September and 26 September, and to give an interim report to the World Bank Mission on 27 September 1985, at the end of week 3.

Teams A and B completed the audits noted west of the Rift Valley in week 4, commencing 30 September 1985, taking the opportunity to carry out the industrial audit at East African Sugar Industries in the same week. Team D completed the audits of Kapset and Chebut during week 6, commencing 14 October 1985.

(c) Audit Schedule

No.	District	Factory	Date	Fuel	Heater	Notes	Capacity (Mkg/a)	Team	Date	Centre
1	MERU	Githongo	76	WOOD	STEAM	(loco)	1.2	B	21/9	Meru-County Hotel
2		Kinoro	84	RFO	AIR	(3)	1.8	B	22/9	Meru-Country Hotel
3	EMBU	Mungania	80	RFO	AIR	(3)	1.8	B	23/9	Embu-Izaak Walton Inn
4	KIRINYAGA	Thumaita	75	WOOD	STEAM	(loco)	1.2	B	24/9	Embu-Izaak Walton Inn
5		Kimunye	79	RFO	AIR	(3)	1.2	B	25/9	Embu-Izaak Walton Inn
6	NYERI/ KIRINYAGA	Ndima	81	RFO	AIR	(3)	1.8	A	21/9	Nyeri
7	NYERI	Gathuthi	77	WOOD	STEAM	(5)	1.2	A	22/9	Nyeri
8		Iriaini	81	RFO	AIR	(3)	1.8	A	23/9	Nyeri
9		Chinga	63	RFO	STEAM	(2)	1.2	A	24/9	Nyeri
10	MURANGA	Ikumbi	71	RFO	STEAM	(1)(2)	1.2	A/B	20/9	Nairobi
11		Kanyenyaini	74	RFO	AIR	(3)	1.8	A/B	19/9	Nairobi
12	KIAMBU	Mataara	64	RFO	STEAM	(2)	1.2	A/B	18/9	Nairobi
13		Kambaa	75	RFO	AIR	(3)	1.8	A/B	17/9	Nairobi
14	NANDI	Chebut	72	WOOD	STEAM	(loco)	1.2	D	TBA	Eldoret-Sirikwa Hotel
15	KERICHO	Tegat	71	RFO	STEAM	(4)(6)	1.8	B	TBA	Eldoret-Sirikwa Hotel
16		Litein	66	RFO	AIR	(4)	1.8	B	TBA	Kericho-Tea Hotel
17		Kapset	81	RFO	AIR	(3)	1.8	D	TBA	Kericho-Tea Hotel
18	KISII	Nyansiongo	66	RFO	AIR	(4)	1.8	A	TBA	Kericho-Tea Hotel
19		Kiamokama	76	RFO	STEAM	(4)(6)	1.2	A	TBA	Kericho-Tea Hotel

Notes:

(1) Mata-Ara has a new fluidised bed dryer installed - the first for a KTDA dryer.
(2) Chinga and Mata-Ara are said to be very expensive to operate. Will be converted to fuelwood (also Ikumbi) as loco boilers become available. Wood is plentiful.
(3) These factories to be converted to wood as fuelwood plantations mature and boilers become available.
(4) Thought unlikely to convert to fuelwood due to shortage of land.
(5) Gathuthi and Kangaita have new steam boilers, all other KTDA steam factories have loco boilers.
(6) Tegat and Kiamokoma are steam, not air heaters as given in Activity Initiation Brief - Annex 1.

APPENDIX J.2

ENERGY SURVEY QUESTIONNAIRE

The purpose of this survey is to assist the KTDA and their consultant team in evaluating the potential for making overall improvements in energy efficiency in the Kenyan tea industry and so reducing fuel costs. The team is also examining the feasibility of progressive substitution from oil to wood (if you are not already using wood).

The team includes specialists on combustion of all fuels, steam generation, steam systems, heat exchangers, electrical distribution and use, energy conservation, and innovative developments such as wood gasification and fluidised bed drying of tea. The team also includes specialists on forestry development and optimum fuelwood cultivation systems, as well as roads, transportation and marketing aspects. Your support by responding to this questionnaire would be much appreciated and will be of great help towards making the survey successful.

<u>MINISTRY OF ENERGY & REGIONAL DEVELOPMENT</u>
<u>Tea Industry Energy Efficiency Study</u>
<u>for the Kenya Tea Development Authority</u>

1. Factory Name and Address: ______________________
   Altitude (metres above sea level):
   ____

2. Telephone: ______________________________

3. Person to contact and position: ______________
   ____

4. Number of Employees at factory: ______________

5. Number of weeks worked per year: __________
   Dryer hours per week? ______________

6. Fuel used per year (All data should be for a full year) ______
   ____

   Specify months: ____________________________

   6.1 Fuel Oil (Litres - L) ______________
       Cost per litres (KSh/L)______________

       Total Cost (KSh) ______________
       Purpose fuel used ______________

   6.2 Industrial Diesel (Litre - L) ______________
       Cost per litre (KSh/L) ______________
       Total cost (KSh) ______________
       Purpose fuel used ______________

6.3 Kerosene (Litre - L) ______________________
Cost per litre (Ksh/L) ______________________
Total cost (KSh) ______________________
Purpose fuel used ______________________

6.4 Wood (tonnes or cubic metres) ______________________
Moisture content (%) ______________________
Source ______________________
Cost (per tonne or cubic metre) ______________________
Total cost (KSh) ______________________
Purpose fuel used ______________________

6.5 Any other fuel ______________________ (Tonnes or ?)
Cost (KSh) ______________________
Purpose fuel used ______________________

6.6 Electricity - Private Generators (kWh) ______________________
Fuel used for this purpose (litres) (type) ______________________
Total cost for fuel (KSh) ______________________

6.7 Electricity - Purchased from KPL (kWh) ______________________
Maximum demand (kW) ______________________
KPL Tariff Schedule ______________________
Total cost (KSh) ______________________

7. Production Details

7.1 Quantity (kg made tea per day) ______________________
7.2 Quantity (kg made tea per year) ______________________
7.3 Quality (Please comment) ______________________
7.4 What improvements would you wish to make to improve production and quality? ______________________

____

8. Vehicle Fleet and Operating Costs

8.1 Please list all the vehicles in your fleet, especially those which are used for hauling green leaf giving the make, capacity in tonnes, fuel used and estimated annual kilometres travelled.

Vehicle	Make	Age (Yrs)	Capacity (tonnes)	Fuel Type	Annual Kilometres	Replacement Cost (KSh)
Lorries						
Other Vehicles						
Total	Number:					

8.2 Please Estimate the Annual Vehicle Operating Cost of Your Fleet (KSh)

- Drivers wages — KSh
- Maintenance (and Repairs, Tyres etc) — KSh
- Rescue Cost — KSh
- Fuel — KSh
- Vehicles Depreciation — KSh
- Registration, Insurance etc — KSh

Total vehicle operating costs

Vehicle operating costs per km.KSh/km

---

9. Total transport fuel use:

9.1 Gas Oil (L) ______________________

Cost (KSh) ______________________

9.2 Petrol (L) ______________________

Cost (KSh) ______________________

10. List fuel stored at factory and state approximate number of days fuel supply at average use for each fuel you store. State type.

10.1 Fuel storage (days) ______________________

Amount (L) ______________________

10.2 Fuel storage (days) ______________________

Amount (L) ______________________

10.3 Fuel storage (days) ________________

Amount (L) ________________

11. List types and amounts of any oil fuel substitutes used, or available but not yet used (for example coffee husks, bagasse, etc.)

11.1 Substitute fuel type ________________

Amount (tonnes) ________________

12. If you now use fuel oil would you consider conversion to wood? Please describe the problems you expect in such a conversion, for example:

12.1 Source of wood supply? ________________

12.2 Cost of wood supply? ________________

12.3 Cost of new plant? ________________

12.4 Likely benefits to you? ________________

12.5 Discuss any other issues you think are relevant to conversion from fuel oil to cheaper oil. ________________

____

____

____

____

13. Combustion Plant

Please describe your existing combustion plant. State first if you have steam heater (Yes/No) or an air heater system (Yes/No).

13.1 Steam or air heater ______

13.2 Manufacturer/Model ______

13.3 Year installed ______

13.4 Normal fuel ______

13.5 Alternative fuel if any ______

13.6 Fuel preparation if any ______

13.7 Rated thermal capacity steam (tonnes/hour) ______

______ or kW ______

(or Btu/h) ______ (or hp) ______

Hot air (GJ/hour) ______ (or kW) ______

13.8 Operating hours (h/year) ______

13.9 If a boiler, does it have an economizer? (Yes/No) ______

13.10 Is feedwater treated? ______

13.11 Is condensate returned as feedwater (Yes/No) ______

13.12 If yes, approx what (%) ______

13.13 Do you do regular combustion efficiency checks (Yes/No)

13.14 If yes, what efficiency levels do you expect as normal (%) ______

Best Possible (%) ______

13.15 Is your steam and return system in good order, well insultated with proper traps? ______

13.16 Have you any thoughts on how you could economize on fuel usage and increase unit efficiency? If yes, describe your proposal and approximate costs. ______

______

______

14. Drying Plant

Please describe your existing tea drying plant in as much detail as you can. Attach further information to this questionnaire if you wish.

14.1 Drying Plant	Unit 1	Unit 2	Unit 3

14.2 Manufacture and Model ______

14.3 Year installed ______

14.4 Dryer type ______

14.5 Rated capacity (kg/h) ____________________

14.6 Maximum capacity (kg/h) ____________________

14.7 Steam or air heated ____________________

14.8 Typical temps: Day ____ deg C Night ____ deg C

Typical humidity: Day ____ %. Night ____ %.

14.9 Are heat exchangers in good order and well maintained?

____

14.10 Fan details

Make ____________________

Size ____________________

Motor rating (kW or hp) ____________________

Air flow (cfm or cu.m/s) ____________________

14.11 Have you any proposals for increasing energy efficiency of your dryer(s)

____

____

____

15. Electricity generation and usage.

Please provide a simple single line diagram of your system if possible. Describe your private generation plant if installed, or your supply arrangements from KPL if you purchase electricity. ____________________

____

____

____

____

15.1 Supply arrangements (Private generation or KPL) ________

15.2 Supply details (Voltage, system capacity (kVA) etc _____

____

15.3 Generation plant if used ____________________

Manufacturer and model ____________________

Year installed ____________________

Rated capacity (kW) ____________________

Fuel used ____________________

15.4 Please list all motors (kW or hp) and describe connected loads eg. lighting, water heating, pumps, conveyor fans, etc. (attach list) ______________________________

____

15.5 What lighting systems are used? ____________________

15.6 What hot water system is used? ____________________

15.7 Is power factor correction installed? ______________

15.8 Have you any thoughts on how electricity consumption could be saved without loss of plant efficiency? ______

____

____

16. Transport

16.1 System

Please draw a map showing -

- the factory
- the designated buying centres (numbered)
- the roads and routes used to service buying centres (lettered)
- the location of particular trouble spots and alternate routes.

16.2 For each major route please indicate the length in km, the annual tonnage of green leaf collected and hauled over that route and the extent of other traffic on the route. Use Table 16.2.

16.3 How many km of roads are there connecting the factory to its designated buying centres? Please classify roads by composition and state of repair on the attached chart 16.3.

16.4 Do you believe there is a need for bridges or large culverts: If so where? Please mark on map.

16.5 What distance do your lorries travel each year on green leaf collection? ____________________

____

16.6 Could this be reduced without loss of factory efficiency or tea quality? ____________________

____

16.7 What thoughts do you have on possible improvements that could be made to your roads and transport systems? ____

____

____

____

____

16.8 How is your made tea despatched from your factory (eg road or rail) and in what tonnage lots? ____________

____

____

____

____

____

____

____

TABLE 16.2 - ROAD ROUTES LENGTHS AND TONNAGE

Route	Length	Green Leaf Hauled	Other Traffic on Road (Is Tea a large or small share of traffic)
	km	tonnes per year	
A			
B			
C			
D			

TABLE 16.3 - ROAD SURFACE WIDTH AND CONDITION

Surface	Width m	Good	Fair kms	Poor	Bad	Total kms
Macadam						
Gravel						
Earth						
	TOTALS					

Note:

Good road Vehicle not retarded by road conditions in any weather. Normal operating costs achieved without road caused delays.

Fair road Road passable in any weather but vehicle must slow to avoid damage, holes, etc. Delays arising from slow operating speed. Vehicle operating costs increased say 50% above good. Road requires maintenance only.

Poor road Road passable only with difficulty in wet conditions. Delays arising from bogging. Damage arising from rough surfaces. Vehicle operating costs doubled. Occasional need for tractor tow or rescue. Road requires reconstruction.

Bad road Road impassable in wet conditions without assistance from a tractor or other. Vehicle damage arising from road conditions. Long delays. Road requires reconstruction.

16.9 Could the despatch arrangements be improved in your view. If so how?

____

____

17. Packaging and transport of made tea

17.1 Is your tea packed in chests or paper sacks? ______

17.2 Why do you use this method? ______

____

17.3 Which method would you prefer to use, provided the tea buyers did not mind? ______

____

____

____

17.4 Do you use road, rail or a combination of the two for transport to Mombasa? Please describe method ______

____

____

17.5 Why do you use this method of transport? ______

____

____

17.6 Please can you advise your costs for packing (KSh/kg MT)

____

17.7 Please advise your costs for transport from factory to Mombasa (KSh/kg MT) ______

____

17.8 Have you any views on improving packing and transport? For example would you prefer to containerise your production at the factory?

____
____
____
____
____
____
____
____

18. Fuelwood

18.1 Quantity of Fuelwood

1.1 Specify in
(a) Tonnes ____________________
(b) Cubic metres stacked volume ____________________
(c) Cubic metres solid volume ____________________

1.2 Main species used (percent of each) ____________________

1.3 Percentage from ____________________
(a) Native (indigenous forest) ____________________
(b) Forest Plantation ____________________

1.4 Moisture content (wet basis) ____________________
(State how measured) ____________________

18.2 Source of Fuelwood
Percentage of
2.1 Forest Dept. land ____________________
2.2 Smallholder land ____________________
2.3 Other ____________________

18.3 Location of Supply

3.1 Name and distance (in kms) of furthest wood source ______________________________

3.2 Location of most important wood source - Name and kms ______________________________
____

3.3 Estimate average distance of wood transported - kms ______________________________

3.4 How is it transported? (truck, animal, man carry) ______________________________

18.4 Delivered Cost

4.1 Per tonne ______________________________

4.2 Per cubic metre stacked ______________________________

4.3 Per cubic metre solid ______________________________

18.5 Cost Structure

5.1 Cost at roadside ______________________________

5.2 Transport cost ______________________________

18.6 Do you have shortage of wood for:

6.1 Present use? If so by how much per year? ________
(Give amount in tonnes, stacked cubic metres) ____
____

6.2 Proposed use? (as above) ______________________________

18.7 Is there land available to grow fuelwood? __________

7.1 Available for land purchase by KTDA? __________

7.2 For growing by smallholder __________

7.3 On Forest Dept. land __________

If the answer is NO, please say why __________

____

____

____

____

If the answer is YES, please say

(a) How much is available and ________ (in hectares)

(b) How much you think you need ________ (in hectares)

18.8 Does the factory presently have ANY of its own fuelwood forests (ie. owned by KTDA)? __________

18.9 What is being done by the factory to improve wood supply? Please explain:

9.1 To acquire or grow forests __________

9.2 Arrange supply __________

9.3 Grow trial plots of trees __________

9.4 Encourage smallholders to grow fuelwood __________

18.10 Are smallholders interested in growing fuelwood? If NO, is it because of:

10.1 Low price offered __________

10.2 Other reason - Please explain ______________________

If YES - what do you suggest can be done to start a smallholder scheme for fuelwood growing? ______________________

18.11 Is there any other public land which could be used for growing fuelwood, eg. along roadsides, at schools, other land? ______________________

18.12 Do you think there might be any fuelwood available from private estates - especially if they can improve drying efficiency and save on fuelwood? ______________________

18.13 List in summary the main problems and constraints in fuelwood supply ______________________

19. General

Have you any other ideas on how energy efficiency in the tea industry or in your factory might be improved. If so your thoughts would be much appreciated.

Thank you for your time and cooperation in completing this survey. You may be sure that all responses will be carefully used towards energy improvements in the tea industry in accordance with the brief set for the consultant team by the World Bank.

APPENDIX J.3
FACTORY OFFICERS' SEMINAR
MONDAY, 16TH SEPTEMBER 1985

SESSION 1 - Introductory

9:00	Opening Remarks	S.A.R. Bagha
9:10	Introduction of KTDA	P.M. Njoroge
9:20	Introduction of Australian Team	M.S. Nicklin
9:30	The KTDA Energy Problem	R. Cheruiyot
9:45	The Fuelwood Problem	R. Dewar
10:00	Tea Break	

SESSION 2 - Tea Energy Technology

10:30	Kenyan Tea Industry Operations	J.K. Karungu
11:00	Energy Audits - Model Questionnaires and Model Audit Reports	M.H. Thomas
11:15	The Future of Fluidised Bed Drying	J.C. Alles
11:30	Tea Drying Experience in Papua New Guinea	I.A. Gilmour
11:45	Biomass Combustion Efficiency	E.G. Williams
12:00	Discussion on Technology	Team
12:30	Lunch Break	
2:00	The KTDA Fuelwood Problem	D. Chanzu
2:15	Fuelwood Plantation Development	K.M. Gray
2:30	KTDA Factory Operation on Fuelwood	J.M. Karanja
2:45	KTDA Factory Operation on Oil	G. Nduri
3:00	Tea Break	
3:30	Transport of Green Leaf and Made Tea - The Roads Problem	D. Onango
3:45	Open Discussion	
4:45	Summing Up	S.A.R. Bagha
5:00	Close	S.A.R. Bagha

Characters Must Fall Completely in Box!

PAGE 1 OF 2 | OFFICIAL DEPT/DIV ABBREVIATION: EGYS2 | MESSAGE NUMBER | TEST NUMBER (FOR CASHIER'S USE ONLY)

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MR. MARTIN THOMAS, MERZ AND MCLELLAN AND PARTNERS, SYDNEY, AUSTRALIA. COPY TO MR. JOHN SPENCE, COOPERS AND LYBRAND, W. D. SCOTT, SYDNEY, AUSTRALIA; P.M. NYOIKE, MOERD, NAIROBI, KENYA, AND MR. JAMES ADAMS, DIRECTOR, INTBAFRAD, NAIROBI, KENYA.

RE KENYA COAL AND TEA DRAFT CONSULTANT REPORTS. (AAA) AS AGREED, MISSION COMPRISING ROBIN BROADFIELD, REZA KHONSARY AND MYSELF WILL ARRIVE IN NAIROBI FOR A STAY OF UP TO ONE WEEK TO PARTICIPATE WITH GOK IN DETAILED REVIEW OF THE COAL AND TEA DRAFT REPORTS BEGINNING MONDAY, OCTOBER 13. (BBB) REGRET TO SAY ON BASIS OF OUR INTERNAL REVIEW OF THE ABOVE REPORTS WE CONCLUDE THAT THE CONSULTANTS HAVE NOT ADDRESSED OUR COMMENTS ON THE FIRST DRAFTS AS STATED IN OUR MEMO OF APRIL 17, 1986 TO MR. NICKLIN AND REVIEWED FURTHER ON JUNE 25, 1986 WITH MR. SPENCE IN WASHINGTON (REFER TO MINUTES OF THAT MEETING GIVEN TO MR. SPENCE).

CONSEQUENTLY, THE DRAFT REPORTS ARE STILL DEFICIENT IN THE AREAS OF ECONOMIC AND FINANCIAL ANALYSIS AND THE MAIN CONCLUSIONS ARE OPEN TO QUESTION. IN PARTICULAR: (I) THEY ARE BASED ESSENTIALLY ON 1985 DATA AND NO SERIOUS EFFORT HAS BEEN MADE TO INCORPORATE 1986 FUEL PRICES, AND (II) THEY LARGELY IGNORE ECONOMIC CONSEQUENCES OF POTENTIAL INCREASED FUELWOOD

END OF TEXT

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CONSUMPTION. APPENDIX D IS STILL CONFUSING AND SHOULD BE COMBINED WITH APPENDIX F. THE SENSITIVITY ANALYSIS SHOULD BE INTEGRATED PROPERLY INTO THE STUDY. POLICY RECOMMENDATIONS ARE NOT TAILORED FOR THE KENYA SITUATION AND THE PRESCRIBED INSTITUTIONAL ARRANGEMENTS SEEM EXCESSIVELY COMPLEX. (CCC) WE WILL DISCUSS THE ABOVE POINTS IN DETAIL AND MAKE SPECIFIC RECOMMENDATIONS WHEN WE MEET ON OCTOBER 13. IN THE INTERIM, IT WOULD BE HELPFUL IF YOU COULD PREPARE A COMPLETE LIST OF PLANT AND NATIONAL ENERGY DATA AND RELATED ANALYSES THAT YOU HAVE ON DISC AND BRING THE FULL SET TO NAIROBI FOR OUR USE. REGARDS. ROBIN BATES, ACTING DIVISION CHIEF, ENERGY STRATEGY AND PREINVESTMENT DIVISION II, ENERGY DEPARTMENT.

END OF TEXT

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