温溪紙廠籌備委員會報告書

溫溪紙廠原動力之研究附水力發電與蒸氣發電需費比較報告書

譯英籍工程師施濟華與瑞典工程師斐爾頗報告

本報告係依據實業部供給所調查之紀錄，及各商號所開之機器估價單而製成之，關于可水力發電之計算，則採自階圖，浙江省水利局最近三年內水流量之紀錄。

查普通水力發電之創設，皆根據較長期間之紀錄，故于決定採用何種原動力之際，應對此點加以相當之考慮。

關於計算全年製造費時，利率一項，係照借用英庚款向英國購買機器之價，假定爲六釐計算。

關於水力發電廠之土木工程，及房屋等，須在國內招工承包，亦假定其利率爲六釐。

關于折舊費則計算如左：

機器	百分之五
房屋及土木工程	百分之一·五
水力發電廠之鋼壩	百分之三

煤價則照調查之報告估價，每噸唯按拾貳元計算。

此項價格，頗爲穩健，蓋因大量購買，而必可減低也。

紙料廠與紙廠，預計每日工作廿四小時，可出新聞紙三十五長噸，係以三分之一亞硫酸木紙料，與三分之二機械木紙料合製而成之，本廠假定每年工作三百五十日，則全年可出紙一萬二千二百五十噸。

甲　水力發電廠及所需蒸汽廠

照浙江省水利局紀錄計算，尚水流量在常態時，可發水力約五千四百馬力，或四千啓羅華特。

現有兩種設計如下：

設計一　建一活動水壩，以便視水流情形而上落之，此水力廠須能于高水位時，發生多量水力，以製額外機械木紙料，而供儲漿之用。

尚低水位時，照水流量紀錄而觀，則其所發之最高水力，不足以供亞硫酸木紙料部，及製紙部之用。

因此，須附設一約有五百啓羅華特容量之蒸汽透平發電機，使上述二部，得以完全工作。

在水淺時期，所需機械木紙料，應從儲漿處取出。

設計二　築一高約十六公尺之混凝土水壩，庶壩上儲有足量之水，足使水力發電廠繼續工作，發生約四千馬力，或三千啓羅華特之電力，終年不輟。

如此則小溪上游仁宮村附近所有田地及村莊，勢將有被水淹沒之虞！此點于估計時，應計及之。

設計一　此項設計之經費，業由一著名外國公司估計，據稱該公司擬以三百五十萬元左右，承築水力發電廠之全部工程。

倘將此項工程分折承包，而以其土木工程部份，由中國行家承辦，則其經費之計算如下列：

一　土木工程部份，混凝土估計約二萬六千左右立方公尺，包括準備船筏經過水壩之特製閘門，暨測量河牀之經費，以及各種不能預算之費。（此費用已較歐洲各國習慣上略低）計算

一、〇〇〇、〇〇〇元

二　活動鋼壩及裝置費

四五〇、〇〇〇元

三　水力與電力機器，暨輸電線，變壓機，開關機等

七〇〇、〇〇〇元

以上共計二、一五〇、〇〇〇元

設計二　本設計祇有約略之需費計算如下：

一　土木工程包括一高約十六公尺之混凝土水壩，並無活動鋼壩，但仍包括一如上述之運船閘門，測量河牀費，及各種不能預算之費用等，約計

一、二五〇、〇〇〇元

二　被淹沒村莊及田地損失費

二〇〇、〇〇〇元

三　水力與電力機器，暨輸電線，變壓機，等全部建設費

七〇〇、〇〇〇元

以上共費二、一五〇、〇〇〇元

如是則兩種設計所需之費，勢將相同，擬於比較表應用設計一，以其計算，係根據廠家之估計，比較眞確也。

水力發電廠附設之蒸汽廠

蒸發亞硫酸木紙料所需之蒸氣量（以每日製造十三噸之窯氣乾燥木紙料爲標準）每小時　五、〇〇〇磅

烘紙三十五噸所需之蒸氣量每小時　一一、五〇〇磅

以上每小時共需蒸氣一六、五〇〇磅

茲照穆健辦法，假定每磅煤可發蒸氣七磅，則每小時所需之煤爲二、三五〇磅。

每年 $\frac{2350 \times 24 \times 350}{2000} = 9870$ 或約一〇、〇〇〇短噸

蒸氣室以供給上述蒸氣量之需要，其建設費如下：

一　蒸氣鍋爐三座，（內一座係後備用）包括鍊式添煤機，過熱器，强制及引誘通風器，軟水器，記錄及度量器，管子，作爐牆之抗火磚，搬煤機等等；又五百啓羅華脫之附屬蒸氣透平發電機一座，包括開關機電線等等。　二五〇、〇〇〇元

二　蒸氣鍋爐及小電力機之房屋　一五、〇〇〇元

以上共需二六五、〇〇〇元

乙　燃煤之蒸汽發電廠

三千啓羅華特或四千一百馬力之蒸汽透平發電機一座，其工作壓力爲每平方英寸三百五十磅，其透平上能抽出上述漿紙所需之蒸氣量，約共需蒸氣每小時四萬五千磅。

此項蒸氣發電廠之建設費如下：

一　蒸汽鍋爐三座（內一座係備用）包括鍊式添煤機，過熱器，强制及引誘通風器，軟水器，記錄及度量器，抗火磚，搬煤機等等；又三千啓羅華特蒸汽透平發電機一座，附屬小發電機一座，配開關機電線等等。　五七〇、〇〇〇元

二　房屋全部建築費　三〇、〇〇〇元

以上共計六〇〇、〇〇〇元

上項蒸汽鍋爐廠，可用兩鍋爐同時工作，則每小時能發生蒸汽四萬五千磅，尚綽有餘裕蒸氣透平之構造，應可抽出一百十五磅壓力之蒸氣以供蒸漿。（每小時約五千磅）及三十磅壓力之蒸氣以供漿紙。（每小時約一萬一千五百磅）

水力發電廠與蒸氣發電廠每年製造費之比較

	甲　水力發電廠蒸氣廠（製造蒸氣供烘煮之用）及二百磅羅華特蒸氣透平發電廠	乙　燃煤之蒸氣發電廠由透平抽出高壓力與低壓力蒸氣供烘煮之用
設備	一　土木建築費一百萬元 二　活動鋼壩四十五萬元 三　水輪電機等等七十萬元 計二百十五萬元 蒸氣廠（製造蒸氣供烘煮之用）及附屬透平發電機二十五萬元 房屋一萬五千元 計十六萬五千元 總計二百五十一萬五千元	蒸氣發電廠全部機器五十七萬元 房屋三萬元 總計陸拾萬元
利息	機器及鋼壩總價一百四十萬元按百分之六計八萬四千元 土木工程及房屋總費一百零一萬五千元按百分	機器總價五萬七千元按百分之六計算計三萬四千二百元 房屋三萬元按百分之六計算計一千八百元

	之六計算計六萬零九百元 總計十四萬四千九百元	總計三萬六千元
折舊	機器總價九十五萬元按百分之五計算計四萬七千五百元 鋼壩價四十五萬元按百分之三計算計一萬三千五百元 土木建築費一百零一萬五千元按百分之一，五計算計一萬五千二百二十五元 總計七百六千二百二十五元	機器總價五十七萬元按百分之五計算計二萬八千五百元 房屋三萬元按百分之一，五計算計四百五十元 總計二萬八千九百五十元
保險	全部建設費二百四十一萬五千元按百分之〇，五計算計一萬二千〇七十五元 總計一萬二千零七十五元	全部建設費六十萬元按百分之〇，五計算計三千元 總計三千元
煤	每年烘漿用之蒸氣約需煤一萬短噸以每噸十二元計算每年需煤費十二萬元 每年低水時期約有一百日約需額外煤五百十噸以每噸十二元計算每年需煤費六千一百二十元 總計十二萬六千一百二十元	每年需煤二萬七千短噸每噸價十二元計三十二萬四千元 總計三十二萬四千元

工資	水力發電廠計一萬二千元 蒸氣廠計七千元 總計一萬九千元	計一萬七千元	總計一萬七千元
機器油零件修理費及雜費	水力發電廠計二萬元 蒸氣廠一萬元 總計三萬元	計二萬元	總計二萬元
額外費	低水時用于分解機械木紙料之機器之折舊金及工作費計一萬二千元 總計一萬二千元		
	全部總計四十二萬零三百二十元	全部總計四十二萬八千九百五十元	

綜觀上項比較，可知發生原動力與蒸氣之全年總費如下：

甲　水力發電廠暨所需蒸氣廠　四十二萬零三百二十元

乙　燃煤之蒸氣發電廠　四十二萬八千九百五十元

水力發電廠全年較省之數　八千六百三十元

約佔發生電力與蒸氣總費百分之三

茲再將兩種電力廠之利弊分別研究之如下

甲　水力發電廠之優點

一　就國民經濟而言，水力計畫自較有利，因其足以保藏一國之天然利源，

二　若僅有富于電力，則水力發電計畫，常能較燃煤之蒸氣發電廠發生低價電流。

三　實際使用之時，水力發電廠可較蒸氣發電廠爲簡便，因其無運煤等工作也。

四　煤價之漲落，並不影響于每單位電力之成本。

五　暗用之煤較少，其率數每年約爲一萬六千五百短噸。

六　水壩之建築與土木工程，可使大數人民得有二年至二年半之工作。

七　電力與蒸氣之每年製造費較省，爲數計八千六百三十元，約佔電力與蒸氣成本百分之二。

乙　水力發電廠之弱點

一　最設之水力發電廠，係根據三年期間所得之記錄而計算之，如此短期之記錄，普通習慣，實嫌不足；普通記錄之期間，至少應在十五年至二十年以上。

二　開辦費須較燃煤之蒸氣發電廠約超一百八十一萬五千元，且即令此大量經費不論，經常費之得節省者亦甚

發。良因既需如此大量之低壓力蒸氣，則以水力發電廠易行製造此項蒸氣，自較不經濟也。

三　紙廠與水力發電廠相距甚遠，水力發電廠管理方面，須另添用技術人員。

四　暴風大雨毀損輸電線等，則有工作中止之虞。

五　遇極大之洪水時，水力發電廠勢將因河水位之極度增高而全部停工。

六　每有盤筏經過，水壩須時起時閉，因而增添各種麻煩工作。

七　因水壩之建築需時較長，紙廠將少一年之營業，若設燃煤之蒸氣發電廠，則開辦較速矣。

丙　燃煤之蒸氣發電廠之優點

一　開辦費約省一百八十一萬五千元。

二　燃煤之蒸汽發電廠可建于紙料廠及紙廠之附近，則可直接受紙廠內技術人員之管理。

三　電力與蒸汽之供給，通年皆有一定；而一定之電力供給，可使紙料廠與紙廠同時工作，如此則可免紙料之儲藏也。

四　蒸氣發電廠可利用其廢氣以蒸煮亞硫酸木漿廠之用，故此廢氣實為副產品。

燃煤蒸氣發電廠之弱點

一　燃煤廠之通常弱點，當為煤屑易污紙張，然此項弱點，實為兩種計畫所同有。

二　每年須購用額外煤約壹萬六千五百短噸。

三　須抽大量之水，以供蒸氣透平廠中冷凝器之用。

四　大量灰屑之處置。

五　資本因投置于煤之堆藏而不能動用，但此點亦發見于水力發電廠附設之蒸氣廠，惟情形則較輕耳。

結　論

就上述各點而論，本紙廠應採用燃煤之蒸氣發電廠最適宜，其理由如下：

一　開辦費約省一百八十一萬五千元。

二　常年製造費所差甚少。

三　並無河流漲落及暴風大雨毀損輸電線等而致紙料廠停工之虞。

四　紙廠之各部均可常年照普通情形工作，因此紙料可于新鮮暖熱時送至造紙機上，若紙料而經製造成塊儲藏，必發生種種麻煩。且紙料藏經多時後，雖在氣候佳時，其邊必成乾硬而極難于分解。此種硬邊入造紙機後則起無限困難！紙料在含水百分之七十時儲藏，乃一極不良之法，蓋紙料因微菌之發生，則發酸而腐。

五　所擬設之新開紙廠以附設一燃煤之蒸氣發電爲最宜于工作，因其需大量之低壓力蒸氣也。若僅製機械木紙料，則情形當完全不同矣。

六　照比較表所載，在中國集資建築之水力發電廠，係假定利率爲六釐。設若利率較高，則將影響當年製造費。試以水力發電廠建設費之利息照七釐計算，則燃煤之蒸氣發電廠之當年製造費可較省一萬三千元之譜。就上述而論，蒸氣發電廠之設立，可爲目前設置之建議。

產紙量擬定爲三十五噸已如上述。此產量應爲長噸（每噸二二四〇磅）而非短噸，（每噸二千磅）因此額外之產量，于紙廠之總成本可無甚影響也。

更有言者，本廠之設計，應預定地位以備將來可添置一部相似之抄紙機及其必需附屬機器。第一次擴充後之產量至少應爲每日七十長噸。就第一機使用時所得之經驗，或可裝一規模較大之第二機，如是則可增加產量至每日至少八十五噸以上。

適當圖謀擴充本廠之時，應有更多關於水流量記錄以資參考，屆時當可謀水力發電廠之建設也。

廿四年七月六日

譯英籍顧問工程師施滌華溫溪紙廠意見書

逕啓者，茲附呈溫溪新聞紙廠各項報告書全份，敬祈　督核。查水力與蒸氣發電比較之報告書係瑞典工程師斐爾福君所擬，其中關於製紙部份，乃由鄙人參加意見。至於水力發電廠與蒸氣發電廠之比較一項，因已詳余報告書中，此處不再贅述。然就上項報告書中，可以看見原動力廠之選擇，頗有積實種際問題應加討論者，即若決定採用蒸氣發電廠，則製出之紙張當較優良也。

關於製造費部份之報告，已詳列附表隨同附奉。所開價格，係取穩健方面計算而得，並無偏向減低製造費之用意，本廠在初辦時期須照所述之成本製紙，迨後職工得有經驗，則製造費當可減低。本廠之設計，使其製成之紙張含有較多之亞硫酸木紙料成分。其主要理由有二，第一，即中國杉木之纖維雖長，顯頗細弱，然其所製成之亞硫酸木紙料則極佳，但機械木紙料則比較由歐美木材所製成者爲弱，故須多製亞硫酸木紙料，以增強紙張，使與舶來品相等。第二，即所有工人對於新聞紙之製造殊欠經驗，亞硫酸木紙料成分較多之紙，在抄紙機上旋轉較易，且增加其强力，致在抄紙機上不易破斷，倘紙在抄紙機上破斷，則其產量效率減低。是紙之愈堅靱，則其破斷之困難愈少，本廠今擬以三分一之亞硫酸木紙料以製紙，則將來抄紙機上之破斷困難可免。歐美有最好之紙廠，僅用亞硫酸木紙料百分之十以製造新聞紙。然應注意者，即由歐美木材所製成之漂白木紙者

，其質地與由中國杉木所製成者各有不同也。

茲用中國杉木製成之亞硫酸木紙料，其質甚佳，故將來本廠所製成之紙，必能有銷來紙張之强韌及光滑也。

實業部曾派遣調查團前往溫溪調查此項設計，而對於運輸方面，尤爲注意，前次調查擇有兩處可作廠址之用，姑稱之爲第一廠址，與第二廠址。

第一廠址，位於甌江之南岸，此廠址優點甚多，如場地廣闊，有餘地以備擴充，水深可通艙雙，及其河岸形勢易於建築碼頭，所惜者，數年前曾爲大水所淹沒，深及十英尺許，故調查同人咸認爲不能滿意。況潮高時，或有咸水浸入之虞，若此咸水流入蒸氣鍋爐內則困難發生矣。

第二廠址，位於甌江北岸，雖較第一廠址略小，然較適用，且有餘地可以再添置二造紙機之地位。惟因江水漲落變化甚大，仍恐不免爲大水所侵襲。一九一一年第二廠址亦曾爲大水所淹沒，其原因或係暴雨所致，此事或將重見，而大水入廠，則損失必鉅，故吾人建議，填高地基，以防此種毀壞之發生，照地勢觀察，填高低窪，尚非困難，廠邊有深水；運輸原料與成品等，極其便利，此廠址更有一優點，即浙江省公路經過本廠，可直達溫州青田之間，造紙所用之水可即將江水抽入濾清室，經過極簡單之濾清手續，即可應用。本段當購自上游之林地，且可約定編成木筏，任其順流而至廠邊。木筏拆開後，裝載至一特製之運木機上，該機從水面將木

下列為建築紙廠之資本概算，（所有一切建築費連流動資金均包括在內）

機器總價（每二十四小時製造新聞紙三十五噸之機器及蒸氣發電廠暨其他一切運輸裝置費）三，二九〇，〇〇〇元

購買基地一百畝　一〇，〇〇〇元

房屋及混凝土工程等（包括填土及小碼頭）　五〇〇，〇〇〇元

一〇〇，〇〇〇元

設備總費

以上總共建置費（查英庚款項下足以支付此數）　三，九〇〇，〇〇〇元

流動資金　六〇〇，〇〇〇元

總共資本金　四，五〇〇，〇〇〇元

每年所需木材：

製造亞硫酸木紙料每噸需木段　九七條

製造機械木紙料每噸需木段　五五條

總計每噸紙應需木段七十三條。以七十三條乘每日出紙三十五噸再乘三百五十日，等於八九四，二五〇條，每條以三角計，則每年木材價需二六八，二七五元

每年所需煤：

每噸紙需煤四，四〇八磅，等於每年二七，〇〇〇噸。以煤價每噸十二元計算，則每年需煤三二四，〇〇〇元

照成本概算表中所述，一百十一元五角可以製成捲筒或散令紙，作運到上海交貨價。假定以百分之五十製造散令紙。以百分之五十製造捲筒紙。茲經調查散令與捲筒紙之平均市價爲每噸一百四十三元四角四分。則以成本價比較，每噸可獲利三十三元。即每年贏餘爲三九二，〇〇〇元。設大量運煤，其價頗有減低之可能，如每噸減到十一元三角，則紙之製造成本我每噸可減少一元，或每年可減少一二，二五〇元。每年贏餘可增加至四〇四，二五〇元。現市價每噸紙爲一四三，四四元，即如上述可獲贏利三十二元。實等於百分之二十二純益。在目前新聞紙低價聲中，實一極好之利益也。

因此可知此廠爲一厚利之事業。然因亦木材煤炭人工等低廉，故製成之新聞紙成本方能如此低廉。

每日製造三十五長噸之廠，要爲最適當之產量。倘較小之紙廠，其經營決不能如此經濟。因其工資除運輸外，當與大廠無異也。若紙廠產量較大，而僅用一抄紙機則因紙幅較闊，必發生種種困難。

然若將來拓充時，所添裝之機，則因職工使用抄紙機經驗充足，可裝一較闊之機約闊二百英寸至二百三十四英寸。

本報告所有資本，係採自各方面所得之估價單，至其他若無確實之估價時，則其價格與數量悉根據從前通行情形與經驗計算之。此致

溫溪紙廠籌備委員會：

顧問工程師施滌華具　二十四年八月三日

譯施滌華工程師報告書附註

茲聞司徒錫君與新聞報館總經理汪伯奇君談，據稱年來最低之新聞紙市價，爲長噸英金八磅（關稅在外）在上海交貨。

按今日匯水英金每磅合國幣十二元九角，則英金八磅應中合國幣一百零三元二角。

查新聞紙之製造成本，實不能在此市價之下，故此種價格，當係傾銷無疑。今再將關稅加上，查捲筒紙關稅值百抽七，五，則每噸應抽七元七角四分，連同上數一百零三元二角即合每長噸一百十元零九角四分。

前報告書中業已詳述倘如煤價按每噸十二元估計，則新聞紙之製造成本在上海交貨爲每噸一百零九元七角四分，核與上項傾銷比較，則其價仍可獲利一元二角。是每年盈餘爲一萬四千七百元。

本廠將來之製紙不僅製造捲筒紙，其於製造散令紙時，製造成本費並不增加。但此散令紙市價較昂，故將來之獲利，實注意於此。

聞最近司徒錫君又訪申報館總經理馬蔭良君據稱新聞紙每噸英金八磅是爲最低價，現在市價已趨上漲，是可證明八磅價格純係「傾銷」而已。

二十四年八月三日

成本概算

每日(二十四小時)製造新聞紙三十五長噸，每年開工三百五十天，產量爲一萬二千二百五十長噸，其製造成本估計如下：

(甲)機械木紙料部

每日(二十四小時)製造含6—7%水份機械木紙料二十六長噸，則每年(三百五十天)產量爲九千一百長噸

每噸煤有熱力一萬英度其價格爲十二元

一、原料價

運至廠邊交貨之75"×84"絕對乾燥木段去皮每條計重四十六磅合價洋三角

每噸機械木紙料(去皮損失2%其產額爲90%)約需木段五十五條

每噸機械木紙料需木材價95×30=16,30元

二、原動力價

機械木紙料機器約需電力1,50 KW約合全廠電力40%

每年其原動力價爲$430,000(全廠電力)×,40=172,000元

每噸機械木紙料需原動力爲172,000/9,100=18.89元

三、薪資

每年管理及監工費 27,500.00元

工頭三人……750.00元

工匠十六人……850.00元

小工十五人……140.00元

每噸機械木紙料需工資(連修費)爲4.12元

四、紙料石及銅絲網等雜件

每噸機械木紙料需上項雜件1.40元

五、篩板·皮帶及機油等

每噸機械木紙料需上項篩板等0.75

六、折舊費

機器折舊按5%房屋折舊按1.5%

每噸機械木紙料需機器房屋折舊費2.30元

七、資本利息及保險

資本利息按9%保險按1/2%

每噸機械木紙料需資本利息及保險1.00元

以上七項合計49,17元即每噸機械木紙料製造成本需49,17元

(乙)亞硫酸木紙料部

每日(二十四小時)製造亞硫酸木紙料十三長噸每年(三百五十天)產量爲四千五百五十長噸

一、木材價

每噸亞硫酸木紙料約需木段九十七條木材每條三角

每噸亞硫酸木紙料約需木材價97×30＝29,10元

二、硫磺價

每噸亞硫酸木紙料約需硫磺134磅硫磺每噸10元

每噸亞硫酸木紙料約需硫磺價7,00元

三、石灰價

每噸亞硫酸木紙料約需石灰石853磅石灰每噸16,00元

每噸亞硫酸木紙料約需石灰石價1,50元

四，蒸汽及電力價

蒸汽亞硫酸木紙料需用蒸汽及電力約350KW.約合全廠原動力43%

每噸亞硫酸木紙材料需蒸汽及電力費9,50元

五，薪資

每年管理及監工費　12,500,00元

工頭三人　700,00元

工匠三十人　350,00元

小工十五人　140,00元

每噸亞硫酸木紙料需薪連修理5,25元

六、皮帶，機油等雜件

每噸亞硫酸木紙料需上項雜件2,50元

七、修理材料

每噸亞硫酸木紙需修理材料2,50元

八、折舊費

機器折舊按5%房屋折舊按1,3%

每噸亞硫酸木紙料機器房屋需折費10,08元

九、資本利息及保險費

利息按6%保險按1/2%

每噸亞硫酸木紙料需資本利息保險費14,00元

以上九項合計83,10即每噸亞硫酸木紙料製造成本需83,10元

(丙)製紙部

以2/3機械木紙料1/3亞硫酸木紙料製成之新聞紙(37G M/M²重量)

每日(24小時)產量為35長噸或每年(350天)產量為12,250長噸其成本估算

一、機械木紙料每長噸成本價49,10元(參照估計甲)假定在製紙損失4%即1,560磅合34,30元

二、亞硫酸木紙料每長噸成本價83,10元(參照估算乙)假定在製紙損失5%即785磅合29,65

三、製紙電力及烘紙蒸汽約1,200KW約合全廠50%

每噸紙約需原動力17,50元

四、薪資

每年管理及監工費	30,000.00元
工頭三人	700.00元
抄紙機管理工匠三人	700.00元
抄紙機副手六人	550.00元
切紙包紙部工頭一人	700.00元
工匠十五人	350.00元
小工四十五人	140.00元
每噸紙薪資(連修理)	3.30元

五、皮帶滑油等雜件

每噸紙需用上項雜件	4.50元

六、松膠及其他顏料等

每噸紙需用松膠及其他顏料等	1.15元

七、包裝材料

每噸紙需用包裝費　1,00元

八、修理材料

每噸紙需用修理費　2,00元

九、折舊

每噸紙需房屋及機器折舊費　3,60元

一〇、資本利息及保險費

每噸紙需資本利息及保險費　9,00元

以上十項合計107,4元即每噸紙之製造成本爲一百零七元四角再加運至上海運費每噸五元合計爲112,40元(上海交貨)

查現在捲筒紙每噸市價　126,88元

散令紙每噸市價　〃　160,00元

假定全廠產量以捲筒及散令各半則其市價爲一百四十三元四角四分與成本比較每噸紙可得純益三十一元零四分姑作三十一元算即每年之純益爲三十七萬九千七百五十元

對於紙廠原動力之意見

徐善祥

英國工程師司梯華及瑞典工程師裴爾福，已將造紙廠計畫詳細研究，擬具意見書主張採用蒸汽發電以代水力，其理由如左。

（一）設備費約可節省一百八十餘萬元。

（二）製造成本，並不增加甚巨。

（三）工作可繼續不斷，絕不受洲水或洪水之影響。

（四）木漿製成後即可直接造紙，無久置霉爛之虞。

（五）造紙廠本身需用之低壓蒸汽甚多，若用蒸汽機發電，即不須另備鍋爐。

（六）若利率在六釐以上，（假定七釐）則蒸汽發電之開支，比水力發電約可省一萬三千元。

然主要之原因，乃在水量及其他記錄，均不充足，冒險鉅款以辦此無甚把握之水電廠，危險實多，且溫州方面可以發展之新工業，爲數極少，專爲一紙廠而建築水壩，經濟上亦不合算，善祥前製之報告中，亦曾注意及此，若必俟種種調查完成其工作，則曠日持久，造紙計畫，恐非二三年內所能實現，爲促進事業起見，自應採取英瑞工程師之意見，改用蒸汽機以發電，較爲妥善也。

該工程師等所估四千馬力之電廠價值國幣六十萬元，事實上恐難辦到，至少或須增加三分之一，然較之水電廠所需之設備費，所省總在一百萬元以上，可以斷言。

廠址問題

紙廠與木漿廠不能相離過遠，其理由已詳原報告中，故若在小溪用水力發電，則造紙廠之地點，爲節省輸電計，必須設在溫溪或溫溪以上，今若改用蒸汽發電，則廠址問題，自無設在溫溪附近之必要，（即仍設該處，亦必在溫溪以下，愈近溫州愈妙，）或可變更計畫，將全廠改設在上海附近，茲將二者之利弊，分別言之。

設廠在溫州附近之利，（一）發展內地工業，（二）鄰近原料產區，（三）普通工資較廉，（四）地價較低。

設廠在溫州附近之弊，（一）輸運不便，燃料及化學物品之價較昂，（二）建築材料除木材外，多不產在鄰近，（三）特種工人（如機匠等），仍須雇自外埠，工資甚昂，（四）離新聞紙市場較遠。

設廠在上海附近之利，（一）交通便利，燃料及化學物品均廉，（二）特別工匠，甚易招雇，（四）機器廠林立，機件如有損壞，修理便利，不必多備車床等件，（五）建築材料價廉，（六）無須另設推銷處，（七）所用木材，不必限於溫產。

設廠在上海附近之弊，（一）離原料產區較遠，八尺木段，須用輪船或民船運滬，（海水過鹹，推排漢木，則木質變化，不易製漿，）（二）普通工資略昂，（三）地價較貴，（四）有集中工業於上海一

草之蘇。

總之此次所辦紙廠，必期完全商業化，故廠址之最後決定，全視製造成本爲標準，似應請實業部主管司科及管委會專家，將下列諸項，作切實之詳細調查。以資比較。

溫州方面應調查者，(一)各種建造材料之價格，(二)煤價，(三)各種工資，(四)地價，(五)到廠交貨之木價，(六)新聞紙至上海之運費，(七)在溫州設木材購買處之每日費用，

上海方面應調查者，(一)各種建造材料之價格，(二)煤價，(三)各種工資，(四)地價，(五)到廠交貨之木價，(連運費在內)，(六)在上海設推銷處之每日費用。

原動力及廠址兩問題決定後，即可訂購機器，建築廠屋，預計一年半之內，可以完成一切工作，開廠造紙矣。

廿四年七月廿九日

選擇廠址問題之商榷

司徒錡

紙廠廠址選擇主要條件，如：(一)原料之供給；(二)市場之銷售；(三)工人之招雇；(四)運輸之便利等等。今本廠廠址選擇，即根據上列原則，就預定各地點詳加調查，分別比較而後確定之。徐委員善祥現以水力發電廠既經放棄，則本廠之廠址是否仍應設在溫溪，或變更計劃，將廠址改在上海附近爲言，茲特就其提出溫州上海兩地所應調查各點，加以比較，與本會諸君一商榷焉。

(一)各種建築材料之價格：

本廠建築除一部係鐵架外，其大部份係用三合土建築之，故其所用沙石，如在溫州附近建築，幾可就地掘取，至於鐵筋或建築材料等，則上海溫州兩地，均須仰賴外洋之供給，其差別者，祇溫州運費略高耳，預計約一成左右。又查現所擇定溫州附近之馬溝爲廠址，其地基堅固，於建築上頗有不少便利，設在上海，則深恐其將來地基，建築必較爲昂貴。

(二)煤價：

查現在開灤煤礦之煤，在上海交貨每噸價爲九元五角，而同樣之煤，在溫州交貨爲每噸十元零五角，再加運力八角，共到馬溝廠址，每噸共合十一元三角，核與上海煤價，則每噸相差一元八角，但在上海之小工工資昂

費，卸煤費每噸需在一二元之間，是煤價一項，溫滬兩處相去亦屬無幾。

（三）各種工資：

本廠所用特別工匠甚少，大半爲普通工人，此項工人之工資，溫州較上海可減省三分之一，卽特別工匠，或必須別處招雇，但亦在鄉間居住，生活低廉，工價或可稍遜，亦未可知。

（四）地價：

查現在所擇定之馬埠，地價最高者約每畝在百餘元，最平者每畝約四五十元，平均每畝約在百元左右，倘在上海靠河岸可資設廠之地，每畝總在三千元以上。

（五）到廠交貨之木價：

杉木在乾燥時每噸約四十九條，查每條在溫州交貨市價三角，是每噸木價爲十四元七角，再由溫州運至上海，運力每噸約七元，是在上海交貨每噸木價爲二十一元七角。杉木之在運輸時，不能絕對乾燥，其含水分約在百分之十左右，此加重分量，則運價當較加多，今姑以此數計算，及假定每噸紙用木一噸半，則其成本在上海比溫州應多十元零三角。

（六）新聞紙至上海之運費：

新聞紙至上海之運費，爲每噸五元。此項運費，在施滌華工程師之製業成本概算報告書內，已將此運價列

入計算，故其盈餘項下，已包括此運價。

（七）在溫州設木材購買處之費用：

木材之產地在龍泉一帶，將來須另設購買所於材區，故對於廠址之設在溫州或上海，並無影響。

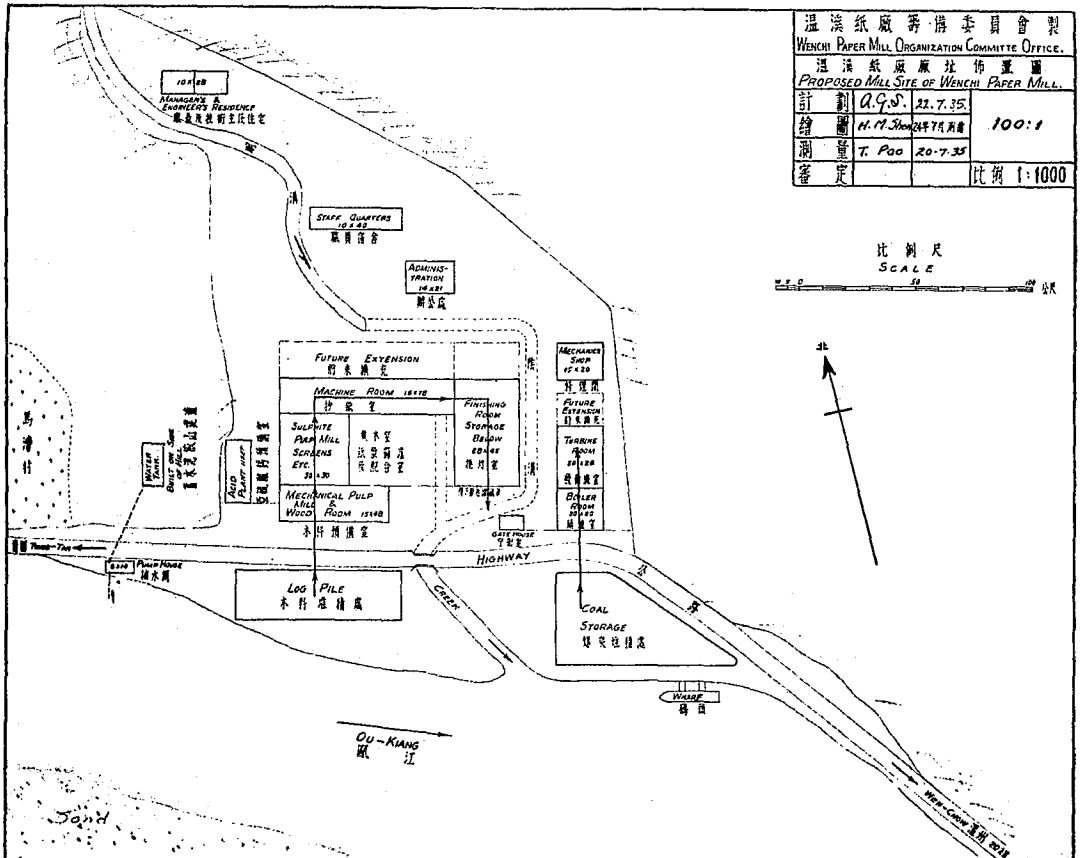
（八）上海設推銷處之費用：

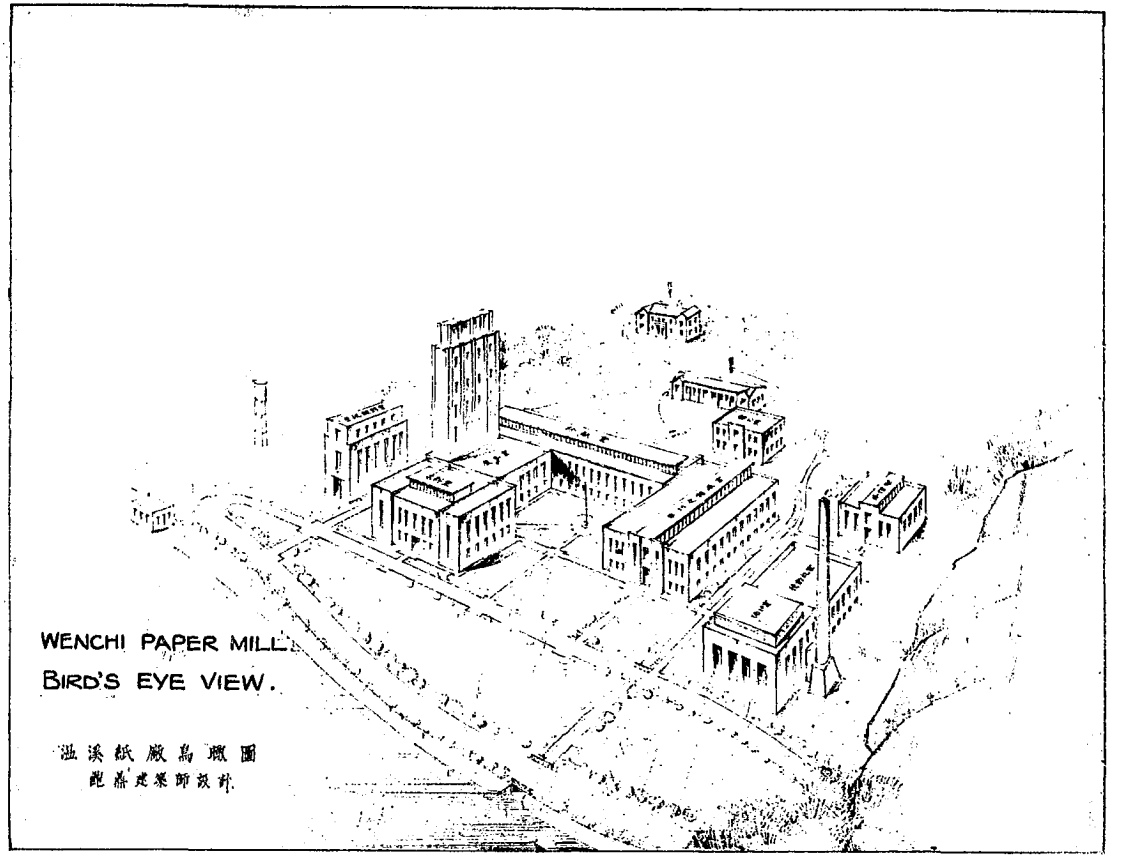
推銷方面，因商場之種種習慣，須另立機關，方易暢銷，故將來本廠之推銷，似應另行招商承辦，是推銷處之費用，於廠址之選擇，可無顯著關係。

綜上以觀，本廠似仍設在溫州附近爲宜，尤以木材之運輸太昂，爲其最大原因。以之與製成之紙相比較，則其成本每噸除紙之運力外，應增高五元三角，是每年增加六萬四千九百二十五元；則每年盈餘項下，減少百分之十六以上，倘若廠址既確定在溫州，則以愈近溫州爲愈適宜。月前曾由鮑開建築師組織測量隊，前往溫州沿甌江之上游，作實地之測勘，結果擇定距溫州二十公里之馬灣爲廠址爲最適宜，蓋以其地勢高，可免洪水之患，面積縱橫有百餘畝，可預留有餘地，爲將來擴充之用。交通則陸運有公路，直達廠址，水運係沿甌江河岸，木材可由林區編成木筏，浮至廠邊，煤與硫磺及製成之紙張，亦可由小火輪裝運，尤以馬灣河面在最高潮時，適可避免鹹水之侵襲，則鍋爐用水可就地抽取，此亦實爲此次選擇廠址主因之一也。

（廠址地勢與廠房之佈置詳見附圖）

二十四年八月四日


溫溪紙廠籌備委員會製
WENCHI PAPER MILL ORGANIZATION COMMITTE OFFICE.
溫溪紙廠廠址佈置圖
PROPOSED MILL SITE OF WENCHI PAPER MILL.
計劃 A.G.S. 22.7.35.
繪圖 H.M.Shen 24年7月 沈鳴鏘
測量 T. Poo 20-7-35
審定
100:1
比例 1:1000
比例尺
SCALE
北
MANAGER'S & ENGINEER'S RESIDENCE
職員及技術主任住宅
STAFF QUARTERS
職員宿舍
ADMINISTRATION
辦公廳
FUTURE EXTENSION
將來擴充
MACHINE ROOM
抄紙室
SULPHITE PULP MILL SCREENS ETC.
MECHANICAL PULP & WOOD ROOM
木料預備室
FINISHING ROOM STORAGE BELOW
MECHANICS SHOP
FUTURE EXTENSION
TURBINE ROOM
BOILER ROOM
WATER TANK
ACID PLANT
PUMP HOUSE
抽水間
GATE HOUSE
HIGHWAY
LOG PILE
木料堆積處
COAL STORAGE
WHARF
碼頭
CREEK
OU-KIANG
瓯江
WEN-CHOW
溫州



WENCHI PAPER MILL.
BIRD'S EYE VIEW.

溫溪紙廠鳥瞰圖
許汝珩建築師設計繪

Shanghai which is $5.00 per ton giving us a cost of $112.40 per ton delivered Shanghai.

The present selling prices of paper in Shanghai are as follows:—

Cost of paper in rolls $126.88
Cost of paper in sheets 160.00

Assuming that 50% of the output of the mill will be in sheets and 50% in rolls, the average selling cost would be $143.44 per ton. The profit per ton after covering for depreciation, interest on capital, insurance, administration and other on cost charges would, therefore, be approximately $31 00 per ton or an annual profit of $379,750.

A profit of $32.00 on a selling cost of $143.44 represents 22.3% profit which is a very good figure considering the present low cost of newsprint.

We are aware that existing stocks of paper in sheets are being sold today at very low prices. It is not fair to a new industry to calculate selling costs on dumping prices. The figure of $160.00 per ton for sheets represents what we should average out from available records as being of a fair price.

(2) Sulphite pulp (see estimate sheet B) allowing 5% losses in the paper making department say 785 lbs. at $83.10 per long ton $29.05 .....$31.05.

(3) Steam for drying the paper as well as electric power 1,200 K.W. all estimated at 50% of the total running cost of the steam and power plant $430,000 per annum.

Therefore, the share to be carried by the paper mill will be $215,000 per annum.

(4) Salaries and wages	$ per annum
Administration and Superintendence	20,000.00
3 shift foremen (Chinese)	700.00
3 first machine tenders	700.00
6 back tenders	550.00
1 foreman for finishing department	700.00
15 semi-skilled men	350.00
45 unskilled men	140.00

Thus the cost of one long ton of newsprint paper would be:—

a.	The cost of 1,560 lbs. mechanical pulp	$34.30
b.	The cost of 785 lbs. sulphite pulp	29.05
c.	Cost of steam and power	17.50
d.	Felts, wires, belts, lubricants, etc. ..	4.50
e.	Sizing, colouring and finishing materials	1.15
f.	Packing materials	1.00
g.	Materials for repairs	2.00
h.	Superintendence and labour including labour for repairs	3.30
i.	Depreciation 5% on machinery and 1½% on buildings	5.60
j.	6% interest on capital and ½% insurance	9.00
	Total	$107.40.

The cost of manufacturing one long ton of newsprint paper would be approximately $107.40 delivered Wenchow. To this we must add the cost of transport to

3 shift foremen (Chinese)		$700.00
20 semi-skilled men (Chinese)		350.00
15 unskilled men for taking in logs to wood yard and to mill, transport of sulphur limestone, after barking, sweepers, etc.		140.00
Thus one ton of sulphite pulp would cost:—		
a.	Wood 97 logs at 30 cents per piece	$29.10
b.	Labour, including labour for repairs	5.20
c.	Sulphur 220 lbs.	8.00
d.	Limestone 350 lbs.	1.50
e.	Steam and electric power 43,0000/4,500=9.45	9.50
f.	Screen plates, bolts, wires, lubricants, etc.	2.50
g.	Materials for repairs	2.50
h.	Depreciation 5% on machinery and 1½% on buildings	10.08
i.	6% interest on capital and ½% insurance	14.00
	TOTAL	$83.10

Thus one ton of sulphite pulp produced in slush form for immediate use in the paper mill would cost approximately $88.60.

(C) Estimated cost of producing one ton of newsprint paper (47 grammes weight per square meter) with apporximately 2/3 mechanical pulp and 1/3 sulphite pulp:

Output 33 long tons per 24 hours—12,250 long tons per annum, based on the following costs:—

(1) Mechanical pulp (see estimate sheet A) allowing 4% losses in the paper making department say 1,560 lbs. at $49.17 per long ton $34.30 ..... $34.30

Thus one ton of mechanical pulp would cost:—

a.	Wood 55 logs at 30 cents per piece	$16.50
b.	Electric power $172,000/9,100=18.89	18.90
c.	Labour including labour for repairs	4.12
d.	Pulp stones, wires, etc.	1.40
e.	Screen plates, bolts, lubricants, etc.	0.75
f.	Depreciation, 5% on machinery and 1½% on buildings	2.50
g.	6% interest on capital and ½% insurance	5.00
	TOTAL	$49.17

Thus one ton of mechanical pulp produced in slush form for immediate use in the pulp mill would cost approximately $47.00.

(B) Estimated cost of producing one long ton (calculated air dry) of sulphite pulp, produced in slush form for pumping to adjacent newsprint mill.
Output 13 long tons per 24 hours or with 350 working days 4,550 long tons per annum.

All power raised from coal.

Cost of raw Material.

(1) Wood delivered floating alongside mill, the logs practically free from bark. Price of wood as for the mechanical pulp mill i.e. 30 cents per piece (7½" diameter×84" long.)

(2) Sulphur delivered at mill .....$80.00 per ton

(3) Limestone delivered at mill .....$16.00 per ton

(4) Steam for cooking and electric power (about 350 K.W.) will cost approximately 10½ of the total running cost of the steam and power plant, estimated at $430,000 per annum, thus the share to be carried by the sulphite pulp mill will be $43,000.—per annum

(5) Salaries and wages $ per annum

Administration and Superintendence 12,500.00

ESTIMATE OF PRODUCTION COST.

To produce 35 long tons per 24 hours (3,266 lbs. one hour)
12,250 long tons per annum

(A) Estimated cost of producing one ton of mechanical pulp in slush form 6-7% consistency delivered to the storage chests in the mechanical pulp mill. Output of mechanical pulp 26 long tons per 24 hours (calculated air dry) or with 350 working days 9,100 long tons per annum.

All power to be raised from coal in adjacent steam power plant.

(Coal 10,000 B. Th. U's per ton and calculated to cost $12.00 per ton)

Cost of raw material

(1) Wood delivered floating alongside mill, the logs practically free from bank. Price of one log 7½" diameter ×84" long—46 lbs. weight at 30 cents per piece.

Therefore, one ton mechanical pulp (allowing 2% loss of weight in barking and 90% yield) will require 55 logs (approx.).

(2) Electric power for driving machinery (about 1,450 K.W.) will cost approximately 40% of the total running cost of the steam and power plant, calculated to cost $430,000 per annum. Therefore, the share to be carried by the mechanical pulp mill will be $172,000. per annum.

(3) Salaries and wages	$ per annum
Administration and Superintendence	27,50.00
Three shift foremen (Chinese)	700.00
16 semi-skilled men (Chinese)	350.00
15 unskilled men for taking in wood to wood yard and to mill, after barking, sweepers, etc.	140.00

ADDITIONAL REMARKS.

Mr. Waung Pak-Chi, Managing Director of the Sin Wen Pao during an interview, informed Mr. G. S. Seetoo that the lowest recorded cost for newsprint in rolls during the last few years was £.— per long ton C.I.F. & C. Shanghai (including duty).

Taking to-day's rate of exchange, namely $12.90 per £1.— sterling, the price per ton work out to be $103.20.

It is worth noting that newsprint cannot be made economically at the above figure, and that this is undoubtedly a case of dumping.

To this price of $103.20 we must add duty at the rate of 7-1/2% which works out to $7.74 per ton. Therefore the cost of the above paper including duty is $103.20 plus $7.74, equal to $110.94 per long ton.

This price makes it necessary for us to take advantage of the saving in the cost of coal as detailed on pages 5 & 6 of the adviser's report, giving a final price of $109.74 per ton of paper delivered Shanghai. Therefore, we do not make a loss in running the mill even when up against dumping but show a profit, small as it is, of $1.20 per ton equivalent to $14,700 per annum.

We must not lose sight of the fact that we can make paper in rolls or sheets without extra cost and as paper in sheets commands a higher price than paper in rolls, we can depend upon the sale of paper in sheets to enhance our profit. The mill organization must concentrate upon selling as much paper in sheets as possible.

During further conversation with Mr. Ma Ying-Liang, Managing Director of the Shun Pao, the question of the present day price of newsprint was discussed. This gentleman stated that £8.— per ton was the absolute minimum price and indications were to the effect that the prices were rising which makes it more obvious that £8.— per ton is pure "dumping".

(Signed) A. G. STEWART

August 3rd, 1935.

not be run so economically as the wage bill, except for the handling charges for raw materials and the finished article, would be the same as for the larger plant. If the mill were made larger using only one paper making machine, difficulties of a practical nature would present themselves owing to the wider sheet of paper being made. If a second unit were installed, however, a wider machine could be installed, say 200" to 234" in width, as the staff would then be experienced in the operation of the mill and the paper making machinery.

All data given has been taken from various quotations where possible, and in cases where there is available data, prices and quantities have been based on prevailing modern practice.

Yours truly,

(Signed) A. G. STEWART.

Engineering Adviser to Ministry of Industries, Nanking.

73 logs×35 tons per day×350 days equal 894,250 logs per annum at 30 per log equal $268,275 per annum.

Amount of coal required per annum:—

4,408 lbs. coal required per ton finished paper equal 27,000 tons per annum at $12 per ton equal $324,000.

In the report regarding the respective merits of the Hydro-Electric and coal-fired plants the cost of coal was calculated at $12.— per short ton and the comparison between the two forms of prime mover was based on this figure. Any reduction in the cost of coal would, therefore, show up favourably in the running costs of the coal-fired plant. The annual running cost for the steam power plant amounts to $430,000.— per annum at this figure, of which $324,000.— represents the cost of coal, was used in the figures showing the cost per ton of paper. We can now buy this coal at the low price of $12.— per long ton delivered Wenchi, representing a saving of approximately $34,680.— per annum. This reduction in the cost of coal can, of course, be added to the annual profit to $104.74 per long ton or $109.74 delivered Shanghai.

As detailed in the schedule of running costs (based, of course, on the highest cost of coal) the paper can be made for $111.50 delivered Shanghai in rolls or sheets. The average selling cost assuming that 50% of the output is sold in sheets and 50% in rolls works out to $143.44. The profit per ton will therefore, be $32.— and the net profit per annum $392,00.— based on the selling cost. A profit of $32.— on a selling cost of $143.44 represents approximately 22% profit. The foregoing prices are based on average costs over a period and the present uneconomical prices, which cannot continue, have been ignored. (See later for comparison with dumping prices.)

It would appear, therefore, that this mill should prove to be a profitable venture and the low cost of the finished paper is made possible by the low cost of the wood and coal and the cheap labour.

A mill manufacturing 35 long tons per day is probably an ideal output for a new mill in China. A smaller mill could

dry, takes as much as three days depending upon the magnitude of the cracks. With only one digester in the mill, the paper making machine would require to be shut down while these repairs are being effected. Owing to the large amount of fabricated work in the construction of a digester amounting to much more than the cost of the materials, it is not economical to build small digesters, hence the reason for the comparatively large digesters. Apart from practical considerations concerned with the actual manufacture of paper, the foregoing remarks will give some idea of the reasons for the comparatively high sulphite content. The mill as designed is also capable of turning out more than 35 tons pulp per day without forcing the output unduly, and it may be worth considering the possibility of adding one extra grinder and an M.G. machine at some later date for the manufacture of Chinese Cap paper. This equipment will be comparatively inexpensive and there is a large demand for this kind of paper.

The following is a rough estimate of the capital required for the construction of the paper mill, including buildings, etc., all ready to start on regular production:—

Total cost of machinery to make 35 long tons newsprint per 24 hours including coal-fired power station all delivered and erected.	$3,290,000
Purchase of land.	10,000
Buildings and concrete work, etc. including levelling site and small wharf.	500,000
Preliminary expenses.	100,000
Total cost ready to run.	$3,900,000

which is within the amount of money available under the Boxer Funds for this scheme.

Working capital of $600,000 assumed to be raised in China.

Wood required per annum:—

For sulphite pulp 97 logs per ton of pulp
For mechanical pulp 55 logs per ton of pulp
Total per ton of paper 73 logs.

It is further recommended that the paper mill should buy their own timber lands at some future date sufficient to ensure a perpetual supply.

The paper can be made for $106.50 per ton which is quite a low figure and should enable the mill to show a profit (see page five for actual figures) even in these days of intense competition and price cutting in the newsprint market. The price of newsprint today is so low that many newsprint mills are working at a dead loss and several of the older mills have had to shut down. This is a state of affairs that cannot go on indefinitely and if the U.S.A. recover some part of their former prosperity the surplus for export will be absorbed by the U.S. market and the main source of the supply of cheap newsprint will be diverted from the Chinese market. Further, China is at present entirely dependent upon foreign supplies of newsprint and in the event of war or blockade a cessation of the import of newsprint would be an extremely serious matter.

As is the case in many countries, the tariff might be raised a little in order to afford some degree of protection for a new industry. The tariff on newsprint is levied at the rate of 7½% for newsprint in rolls and 33½% for newsprint in sheets. As a result of this, the import of newsprint in sheets has practically ceased. The paper is now imported in rolls and cut into sheets in factories in Shanghai. If the duty were altered and levied on a basis of weight as is usual in other countries, it would help the new mill a great deal. A small increase in duty could then be levied without hardship to the printing houses.

It is to be strongly recommended that the output of the mill be 35 long tons per day. The original scheme was planned for an output of 35 short tons per day. Increasing the output means very little extra on the plant. The grinder room will not be increased. The sulphite mill is not affected by the extra output. The original scheme included only one digester for sulphite and this has been altered. Those digesters are lined with special acid-proof brickwork and in time cracks develop in the lining. These must, of course, be repaired and this work including the time to allow the cement to

mense amount of damage. We propose, therefore, to make up the ground in order to preclude the possibility of any such disaster. Owing to the configuration of the land it would be quite easy to fill up the low portions. There is deep water alongside the mill, and handling of logs, coal and finished paper will present no difficulties. A further advantage of this site is that a highway runs past the mill. This will prove to be very useful and the mill will be more accessible if built on the north side. Water for paper manufacture can be pumped directly from the river to the filter house and the water requires very little treatment. The logs will be purchased from timber lands up river and will be contracted for delivery in rafts floating alongside the mill. The rafts will be broken up and loaded onto a special conveyor which will be extended to pick up the logs from the water level at all conditions of the river loaded into hand bogeys or truck sand stacked in the storage pile ready for use in the mill. A storage conveyor for the log pile such as is used in Canada and the United States is not to be recommended. The wood is rather open in the grain and the rough handling received in the conveyor would be the cause of excessive loss of wood. The Western woods are more close grained than China Fir and in consequence are able to stand rough handling without excessive loss due to splinters, etc.

The forest lands have been the subject of a previous report, and the party from the Ministry of Industries made further investigations regarding the supply of timber. A meeting was arranged with one of the large timber selling organizations and suitable wood was offered at 30 cents per log 7½" diameter×84" long. The total cost of the wood to be purchased per annum amounts to almost $268,275.00 only 5% of the total export of logs from the port. This is a very small proportion of the total market and should not affect the market to any extent. Further, the timber we require for pulping is wood for which there is not much demand as it is too small in diameter for sawing down into planks and, therefore, can be bought very cheaply. There is no danger of any shortage in the supply of wood as the forest lands are ample and the amount of wood cut annually is much less than the potential supply.

the paper making machine the efficiency of the machine on a basis of output is reduced. The stronger the paper the less liability there is for troubles of this nature, and as the mill will be designed to produce paper with 1/3 sulphite pulp content, troubles on the paper making machine should be reduced to a minimum. It is a fact that some of the best mills in England and other newsprint manufacturing countries make newsprint paper having only 10% sulphite pulp, but it must be kept in mind that the characteristics of mechanical pulp made from western woods are different from China Fir.

The sulphite pulp made from China Fir should be very good and paper made in the Wenchi Paper Mill will be equally as strong as imported papers and will in all probability have a better printing surface.

A party were detailed by the Ministry of Industries to proceed to Wenchi and investigate the project, paying special regard to handling facilities. On a previous visit two possible sites have been suggested as being suitable for the construction of a paper mill and we shall refer to these as Sites No. 1, Hsio-Tan, and No. 2, Ma-Wen.

Site No. 1 is situated on the South bank of the Ou-Kiang River. This site has many advantages—there is plenty of space available for extensions, there is deep water for the accommodation of boats and the bank could be easily piled for a loading wharf. Unfortunately there is evidence to the effect that the site had been flooded to a depth of 10 feet some years ago which, of course, made it impossible for the party to approve of it. During high tides there is a possibility of brackish water backing up to the mill site and there would be trouble if this water found its way into the steam boilers.

Site No. 2, on the North bank of the river, although much smaller than No. 1 is more suitable and it appears to be large enough in area to permit the installation of a future paper making machine. Owing to the great fluctuations in the level of the river, it is impossible to find a site which has not been flooded at some time or another. In 1911 Site No. 2 was flooded and probably this was caused by a cloud burst. This may happen again and a flood in the mill would cause an im-

Nanking, 3rd August.

Messrs. Wenchi Paper Mill.
Organization Committee Office,
Shanghai, China.

Gentlemen:

The enclosed reports give various data in connection with the proposed Newsprint Mill at Wenchi. The report regarding the Hydro-Electric Scheme was drawn up by Mr. Ivar Belfrage, a Swedish engineer, the writer collaborating with him on the paper making side. It is not necessary in this report to make any further explanations regarding the comparison between hydro-electric and coal-fired plants as this has been done in the report submitted. It will be seen from the foregoing report that problems of a practical nature enter into choice of power plants and that better paper can be made when a coal-fired plant is used.

The report tabulating the running costs is also enclosed. These figures have been calculated on a conservative basis and have not been shaded in any way for the purpose of showing low and false production costs. The mill should make paper from the start at the ultimate cost per ton stated and as the staff gain experience in running the plant production costs can be lowered. The mill has been designed so that the finished paper will have a comparatively high sulphite content and this is necessary for two main reasons. Firstly, the fibres obtained from China Fir although long are rather slender. The sulphite pulp will prove to be extremely good, but the mechanical pulp will be weaker than pulp obtained from European and American woods. Extra sulphite pulp will, therefore, be manufactured to keep the strength of the paper up to foreign standards. Secondly, the labour available will naturally be quite unskilled in the manufacture of newsprint paper. A paper with comparatively high sulphite content will run easily over the machine and owing to its enhanced strength there should be fewer breaks in the machine. When the paper breaks in

be available and might then justify the building of the Hydro-Electric Power Plant.

Submitted by

(Signed A. G. STEWART (Signed) IVAR BELFRAGE.

Nanking, July 6th, 1935.

a practical nature are introduced. When the pulp has been stored for some time, even in temperate climates, the edges become hard and dry and are extremely difficult to disintegrate. These hard edges find their way to the paper making machine and cause no end of trouble. Storage of pump at 70% wet is extremely bad practice as the pulp gets sour and mouldy owing to bacterial growths.

(e) A newspaper mill such as proposed is ideally suited for working in connection with a coal fired plant owing to the large amount of low pressure steam required. If mechanical pulp only were required the conditions will be totally different.

(f) As will be seen from the comparisons the interest on the capital raised in China for the construction of the Hydro-Electric Plant has been calculated at 6%. If the rate of interest should be higher this will of course affect the annual running costs. With a rate of 7% on the cost of the Hydro-Electric Plant the running cost of the coal fired steam power plant would show up more favourably by approximately $13,000.–

In view of the foregoing, the conclusion of a coal fired steam power plant can only be recommended for the present installation.

As stated previously an output of 35 tons has been suggested and recommended. This output should be calculated as long tons and not as short tons, the extra output making little or no difference to the total cost of the plant.

It is further to be recommended that the mill is designed to permit the installation of a second similar newsprint machine together with the necessary preparatory machinery.

The output after the first extension would then be at least 70 long tons per day. In view of the experience gained during the operation of the first machine it would be possible to install a No. 2 machine of considerable large working width, thus increasing the output to at least 85 tons per day.

By the time arrangements for extending the mill have been made, further data regarding the flow of water will

3. Constant supply and demand for steam and power available all the year round. Constant power supply enables the pulp mills and the paper mills to synchronize, thus eliminating storage of pulp.
4. A steam power plant in connection with a paper mill gives the advantage of obtaining a large percentage of the power required as a by-product from the generation of the necessary steam for process work.

POINTS AGAINST A COAL FIRED POWER PLANT.

1. The general disadvantages with a coal fired station is the possibility of smuts dirtying the paper, but in this case this disadvantage applies equally well to both schemes.
2. Buying and handling of the extra quantity of coal amounting to approximately 16,500 short tons per year.
3. Pumping a considerable amount of water for the condensors in the steam turbine plant.
4. Disposal of large quantities of ashes.
5. Capital tied up in the coal storage, but this applies also in smaller degree to the steam plant in connection with the Hydro-Electric scheme.

CONCLUSION.

From the foregoing statements it will be observed that the coal-fired power plant would be the most suitable in this case for the following reasons:-

(a) Approximately $1,815,000 lower capital expenditure.

(b) Very small difference in the annual running costs.

(c) No possible stoppage of the pulp and paper mills due to fluctations in the flow of the river, storms damaging transmission lines etc.

(d) All departments of the mill can operate at normal capacity continuously. The pulp will, therefore, arrive fresh and warm in slush form to the paper making machine. When pulp is made into sheets and stored, several difficulties of

POINTS AGAINST A HYDRO-ELECTRIC PLANT.

1. For the proposed Hydro-Electric Plant calculations have been made on the basis of records taken over a period of approximately 3 years, which period according to usual practice is much too short. Generally official records must be shown extending over a period of 15 to 20 years.
2. Initial capital expenditure is about $1,815,000 greater than in the case of a coal fired power plant and in spite of this high additional outlay there is but a very small saving in the running costs. This is mainly due to the fact that such a large amount of low pressure process steam is required, which with a Hydro-Electric Plant must be raised in an uneconomical manner.
3. The distance between the Paper Mill and the Hydro-Electric station is so far as to make it necessary to keep separate technical staff.
4. Danger of interruptions due to storms damaging the transmission lines, etc.
5. During extreme floods the Hydro-Electric plant would in all probability have to be shut down completely owing to the extreme fluctuation in the back water level.
6. Complications are introduced on account of the fact that boats and timber rafts have to pass the dam.
7. As the dam and civil engineering work would require such a long time to build, there would be a loss of about one year's run of the paper mill, which with a coal fired power plant requires very much shorter time.

POINTS IN FAVOUR OF A COAL FIRED POWER PLANT.

1. Less capital expenditure required, amounting to $1,815,000.–
2. The coal fired power plant will be built adjacent to the pulp mills and paper mill, thus under direct control of the technical staff at the paper mill.

From the foregoing comparison it will be seen that the total annual costs to produce power and steam will be as follows:

A. With Hydro-Electric Plant and the necessary Steam Plant	$420,320.–
B. With coal fired steam power plant	$428,950.–
Annual saving in favour of a Hydro-Electric power plant	$ 8,630.–

which represents approximately 2% on the total cost of producing power and steam.

Below are indicated various points for and against the two alternative Power Plants.

POINTS IN FAVOUR OF A HYDRO-ELECTRIC PLANT.

1. Taking into consideration national economy a water power scheme is to be preferred as it will preserve the natural resources of a country.
2. If only electric power is required, a water power scheme generally provides current at a lower rate than a coal fired power station.
3. In actual operation a water plant is more simple than a steam power plant as no handling of fuel will be required.
4. Fluctuations in the cost of coal would not affect the cost per unit of electricity.
5. Less quantity of coal would have to be bought and handled, the difference being approximately 16,500 short tons per year.
6. The construction of the dam and the civil engineering work would provide work for a great number of men over a period of 2-2½ years.
7. Saving in annual running costs for power and steam. This saving amounting to $8,630 or about 2% on the cost for power and steam.

COMPARISON TABLE OF THE ANNUAL RUNNING COSTS
OF
AN HYDRO-ELECTRIC PLANT
VS
A COAL FIRED STEAM PLANT

A. Hydro-Electric plant with necessary steam raising plant including 500 Kw auxiliary Steam Turbo-Generator.			B. Coal Fired Power Plant-Process steam extracted from Turbo-Generator at high and low pressures.		
EQUIPMENT.					
a. Civil Engineering work	$1,000,000		Complete steam power plant	$370,000	
b. Steel weirs	450,000		Buildings	30,000	
c. Hydraulic turbines & electric generators, etc.	700,000	$2,150,000			
Steam boilers for process steam and auxiliary turbo-generator	250,000				
Buildings	15,000	265,000			
TOTAL		$2,415,000	TOTAL		$400,00
INTEREST.					
6% on all machinery, i.e. a total of $1,400,000	$84,000		6% on all machinery i.e. $370,000	$24,200	
6% on civil engineering work & buildings i.e. a total of $1,015,000	60,900		6% on buildings	1,800	
Total		$144,900	Total		$26,000
DEPRECIATION.					
5% on machinery $950,000	$47,500		5% on all machinery i.e. $370,000	28,500	
3% on steel weirs i.e. 450,000	13,500		1-½% on all buildings, i.e. $300,000	450	
1-½% on buildings i.e. $1,015,000	15,225				
Total		$ 76,225	Total		$28,950
INSURANCE.					
½% on total installed cost of $2,415,000	$12,075		½% on total installed cost i.e. $600,000	$3,000	
Total		$ 12,075	Total		$ 3,000.
COAL.					
Normal yearly requirement for process steam 10,000 short tons at $12.00 per ton=$120,000			27,000 short tons per annum at $12.00 per ton	$324,000	
Extra coal required during low water period about 180 days =510 short tons at $12.00	$6,120				
Total		$126,120	Total		$324,000
WAGES.					
Hydro-Electric Plant	$12,000			$17,000	
Steam Plant	7,000				
Total		$19,000	Total		$17,000
LUBRICATION, SPARES, REPAIRS & MISC. EXPENSES.					
Hydro-Electric Plant	$20,000				
Steam Plant	10,000		Lubrication, etc.	$20,000	
Total		$30,000	Total		$20,000
EXTRA.					
Depreciation and extra cost of running upbuking and loosening up machinery for mechanical pulp during the low water season	$12,000				
Total		$12,000			
GRAND TOTAL		$420,320.	GRAND TOTAL		$428,950.

B. COAL-FIRED STEAM POWER PLANT.

The steam required for a 3,000 KW or 4,100 H.P. Steam Turbo-Generator arranged for a working pressure of 350 lbs. square inch at the turbine stop valve extracting the above mentioned steam quantities required for cooking and drying would be approximately 45,000 lbs. per hour.

The cost of a steam power plant for this steam quantity would be as follows:

a.	3 steam boilers (one as spare). The boilers complete with chain grates, superheaters, forced and induced draught equipment, water softening plant, recording and metering apparatus, piping, special fire proof brickwork for furnace walls, complete coal handling plant including also one 3,000 KW. Steam-turbo-generator set, small auxiliary set for starting the mill as well as all electric equipment, cables, switchboard, etc.	$570,000.
b.	Complete buildings	30,000.-
	Total cost	$600,000.-

The above steam boiler plant would easily raise 45,000 lbs. of steam per hour with 2 boilers working.

The steam turbine would be constructed for the extraction of steam at 115 lbs. pressure for cooking (about 5,000 lbs. per hour) as well as steam for drying the paper at 30 lbs. pressure (about 11,500 lbs. per hour).

Thus the costs of the alternative proposals would be the same.

In the table of comparison detailed later the cost of Proposal I has only been taken into consideration as the cost figures for this are based upon definite information obtained from various sources.

STEAM PLANT IN CONNECTION WITH THE HYDRO-ELECTRIC PLANT.

Quantity of steam required for cooking sulphite pulp (based upon an output of 13 tons air dry pulp per day) 5,000 lbs. per hour

Quantity of steam required for drying 35 tons of paper 11,500 lbs.per hour

TOTAL 16,500 lbs. per hour

It can safely be assumed that 1 lb. of coal can raise 7 lbs. of steam.

Coal required: 2,350 lbs. per hour

Coal required: $\frac{2,350 \times 24 \times 350}{2,000}$ =9,870 Tons Per Year

or say approximately 10,000 short tons.

The cost of a complete steam boiler plant to raise the above steam quantity would be as follows:

a. 3 steam boilers (one of which would be as spare) including chain grates, superheaters, forced and induced draught equipment, water softening plant, recording and metering apparatus, piping as well as auxiliary steam-turbo-generator of about 500 KW with transformer and complete electric equipment, switchboard, cables, including also fire-proof brick work for furnace walls, complete coal handling plant, etc. .. $250,000.–

b. Building for steam boiler plant and small power plant. 15,000.–

Total cost $265,000.–

When splitting up the contract on various hands with the civil engineering work executed by Chinese firms the costs have been calculated as follows:

a. Civil engineering work comprising about 26,000 cubic meters of concrete work as well as buildings, special lock allowing boats and timber rafts to pass the dam, including also costs in connection with the surveying of the river bed, as well as contingencies and unforseen expenses, which latter have been taken at comparatively low figures as compared with European practice.	$1,000,000.
b. Steel weir completely erected based upon actual offers.	450,000.
c. Hydraulic and electric machinery including also transmission lines, transformer station, etc.	700,000.
Total cost	$2,150,000.

PROPOSAL II.

For this proposal only approximate calculations of cost have been made and these are indicated below:

a. Civil engineering work including a concrete dam about 16 m. high, without steel weir but including lock for boats as before, as well as costs in connection with the surveying of the river bed, contingencies, unforeseen expenses, etc.	$1,250,000.
b. Compensations for flooding the villages etc.	200,000.
c. Hydraulic and electric machinery including transmission lines, transformer, etc., the whole completely erected.	700,000
Total cost	$2,150,000

print paper with the make up of 1/3 sulphite pulp and 2/3 mechanical pulp. The mill is assumed to run 350 days per year, the annual output being 12,250 tons per year.

A. HYDRO-ELECTRIC PLANTS WITH NECESSARY STEAM RAISING PLANT.

From the official records one can calculate that approximately 5,400 H.P. or 4,000 KW could be developed during the normal water flow conditions.

The following two proposals have been put forward:

PROPOSAL I. To build a dam on the movable weir system with the weir adjustable to suit the water flow conditions.

The power plant would be arranged to generate an excess of power during the high water season in order to produce surplus mechanical pulp for storage.

During low water season the maximum available power would be taken out but according to the flow data there will not be sufficient power available to operate the sulphite pulp mill and the paper mill.

An auxiliary steam turbine set of about 500 KW. capacity would, therefore, have to be included in order to run the above mentioned two departments at full capacity.

During this period of low water the mechanical pulp would be taken in sheet form from the storage.

PROPOSAL. II. To build a dam of concrete about 16 metres high so as to obtain a sufficient storage of water above the hydro-electric plant to run continuously generating about 4,000H.P. equal to 3,000 KW. all the year round.

A considerable area would be flooded including villages and this fact has been taken into account when estimating the cost of this alternative scheme.

PROPOSAL I. The cost of this proposal has been gone into by a foreign contracting firm of high reputation and this firm has stated that they would be prepared to undertake the building of the complete hydro-electric plant at a total cost of about $2,500,000.00.

REPORT ON THE WENCHI PAPER MILL SCHEME WITH COMPARATIVE COSTS OF HYDRO-ELECTRIC AND STEAM POWER PLANTS.

The following report prepared by Engineers, A. G. Stewart and I. Belfrage, is based upon information supplied by the Ministry of Industries with cost figures for machinery, etc. taken from various offers received in connection with the paper mill scheme. The calculations regarding water power available have been taken from the enclosed diagram showing the official records of water flow over a period of about three years.

It must be pointed out that generally water power schemes are based upon records extending over a much longer period and due consideration must be given to this fact when deciding which form of prime mover to adopt.

When calculating the annual running expenses the rate of interest has been assumed to be 6% on the cost of all machinery purchased in Great Britain from loans received from the Boxer Indemnity Fund.

For all civil engineering works, buildings etc., in connection with the hydro-electric plant, which work would be contracted in China, 6% interest has also been assumed to be obtainable.

Depreciation has been calculated as follows:

Machinery	5%
Buildings and civil engineering work	1½%
Steel weir for hydro-electric plant	3%

The cost of coal is estimated as per quotations received at $12.00 per short ton which price can be considered to be well on the safe side and will probably be reduced by bulk purchasing.

It has also been estimated that the output of the pulp and paper mill would be 35 long tons per day of 24 hours of news-

REPORT

ON

WENCHI PAPER MILL