平成24年度　環境省委託事業

平成24年度 CDM実現可能性調査

「染色加工工程の総合的省エネ促進プログラム」

(バングラデシュ)

報告書

平成25年3月

(株) PEARカーボンオフセット・イニシアティブ

目 次

I. 概要編

II. 詳細編

III. 資料編

- PoA-DD/CPA-DD (generic), CPA-DD (specific)
- 現地調査報告書
- 省エネ診断レポート

1 基礎情報

1.1 プロジェクトの概要

当該プロジェクトは，繊維加工業が大きく伸びてきているアジアの最貧国バングラデシュで，多くの既存の繊維加工工場において，「省エネ＋節水＋環境負荷軽減」を実施するプログラム CDM（PoA）である．

当該 PoA は，繊維産業の工場（1,000 あまりの工場がある）において，圧倒的にエネルギーと水（と化学薬品）を使用する染色機における染色プロセスを最適化し，染色時間の短縮によって電力，蒸気の消費量の削減できる．

CME (Coordinating/Managing Entity) は，Green Project W.S.T (W.S.T)であり，バングラデシュの繊維加工工場での染色過程において節水・省エネ技術を推進するために設立された組織体であり，当該 PoA の調整・管理，追加 CPA の発掘と実施を行う．

当該 PoA の最初の CPA1 は，Grameen Knitwear（Grameen Group のひとつのメンバー）の工場を対象とし，工場にある 5 台の染色機における染色手法の最適化を行う．主な手法として既存の反応性染色から直接染色に変換し，バッチあたりの電力および蒸気の消費量の削減を図る．

1.2 企画立案の背景

PEAR は，2012 年 2 月のバングラデシュ訪問時に，W.S.T と Grameen Knitwear から，彼らの節水・省エネ推進活動の CDM 化可能性についての相談と将来の CDM 化という点を通じたコラボレーションの可能性の打診があった．W.S.T は，バングラデシュの主な産業である繊維加工分野において，節水・省エネ技術を推進・普及するために，Dr. Engel Wolfram によって設立された非営利組織体である．Grameen グループで Prof. Muhammad Yunus（ノーベル平和賞を獲得）をサポートしている Mr. Ashraful の理解と支援を受け，活動を推進してきている．W.S.T は CDM 化を金銭目的ではなく，質の高い環境認証として位置づけている．

CPA 1 として，W.S.T は，Mr. Ashraful が担当しているグラミングループの一員の Grameen Knitwear の工場において，節水・省エネ技術を導入する．

これは，PEAR の目的である途上国でのエネルギーまた環境問題を，CDM に解決するという点に合致する．コラボレーションにおいては，PEAR が CDM 化を受け持ち，プログラム CDM 化というアプローチをとることで，その活動の普及を促進することとなった．また，質の高い省エネプロジェクトとして，民間の Gold Standard 認証も同時取得を目指すこととした．

1.3 バングラデシュ人民共和国の基本情報

1.3.1 一般事情[5]

図ー1　ホスト国バングラデシュの地図

表-1　バングラデシュの基礎情報

面積	14 万 4 千平方キロメートル（日本の約 4 割）	
人口	1 億 4,231.9 万人（2011 年 3 月，バングラデシュ統計局） 年平均人口増加率：1.34％（2011 年，バングラデシュ統計局）	
首都	ダッカ	
民族	ベンガル人が大部分を占める．ミャンマーとの国境沿いのチッタゴン丘陵地帯には，チャクマ族等を中心とした仏教徒系少数民族が居住．	
言語	ベンガル語（国語），成人（15 歳以上），識字率：56％（UNDP 2011 年）	
宗教	イスラム教徒 89.7％，ヒンズー教徒 9.2％，仏教徒 0.7％，キリスト教徒 0.3％（2001 年国勢調査）	
略史	年月	略史
	1947 年 8 月 14 日	パキスタン（東パキスタン）として独立
	1971 年 12 月 16 日	バングラデシュとして独立

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[5] 出典：外務省ホームページ

1.3.2 経済概況[6]

2010/11 年度(2010 年 7 月~2011 年 6 月)の実質 GDP 成長率は 6.7%と良好であった前年度実績(6.1%)を上回る高成長となった. 近年のバングラデシュの経済成長の原動力である衣料品の輸出, サーヒス産業, 海外就労者からの本国送金はいずれも前年度比で増加した.

1 人当たり GDP は前年度の 684 ドルから 747 ドルへと伸び, 消費市場が堅調に拡大している. GDP を産業別にみると, その 5 割を占めるサービス産業は 6.6%増であった. 旺盛な消費を追い風に, 卸・小売業(GDP 構成比 14.3%)は 6.1%増となった. 運輸・通信業(同 10.9%)は, 国内流通の活発化から陸上運送サービスが伸びて 7.9%増となった. GDP の 2 割を占める製造業は衣料品の生産拡大が寄与して 9.5%増となった. 同じく 2 割を占める農林水産業は 5.0%増とやや低成長であった.

消費者物価上昇率(12 カ月平均)は, 2009/10 年度の 7.3%から 2010/11 年度には 8.8%に上昇した. 食料品の物価上昇率は 11.3%, 非食料品は 4.2%となった.

2010/11 年度の輸出は前年度比 41.5%増の 229 億 2,440 万ドルとなった. 輸出総額の 78.1%を占める衣料品が, 欧米での販売拡大に伴い急増し, 過去最高の輸出額を更新した. ニット製品は 46.3%増の 94 億 8,210 万ドル, 既製服(ニットを除く)は 40.2%増の 84 億 3,240 万ドルとなった. 最大の輸出先である米国では GAP など衣料品専門店の販売が総じて好調であった. バングラデシュ産衣料品は, チャイナ・プラス・ワンとしてバイヤーからの需要は年々高まっているものの, 2009 年後半から始まった国際的な綿花価格の高騰に加え, 国内のエネルギー不足などのインフラ問題は依然として解消されておらず, 自国に原材料を持たないバングラデシュの繊維業界はコスト面で不利に立つ.

2010/11 年度の輸入は 41.8%増の 336 億 5,760 万ドルとなった. 衣料品輸出の増大に伴い, 原材料の綿・同製品が 72.3%増加したほか, 繊維企業の設備需要により機械・同部品か 42.3%増加した. 鉱物性燃料・同製品は, 新たな中小規模の火力発電所の電力源となる石油製品の輸入量か増加した上, 石油の国際価格の高騰も相まって 58.0%増となった. 輸入相手国は中国・イントか上位である.

2011/12 年度に入り, 第 2 四半期から米国の需要減少と欧州債務危機の影響が表面化し, 衣料品の輸出か鈍化した. 特に米国向けのニット製品輸出は前年度同期比で減少に転じた. 他方, 日本やオーストラリア, 南米向けか急拡大しており, 米国における不調を相殺している. バングラデシュが得意とするシャツや下着なとの基本アイテムは比較的不況に強い製品ではあるが, 今後継続的な繊維産業の発展のためには欧米依存からの脱却と新規市場の開拓が鍵となる. バングラデシュ繊維企業はこれまでも海外市場の多角化に取り組んでいるが, 日本, 韓国, オーストラリア, 南米諸国を

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[6] 外務省およびジェトロ・ホームページのデータベースより関連項目を抜粋

重点国に位置付け，輸出拡大に攻勢をかける．

2010/11 年度の対日輸出は，前年度比 31.3%増の 4 億 3,410 万ドルと伸びた．上位 3 品目の衣料品，靴・履物，電気機器・同部品で総額の 8 割を占めた．中でも輸出を押し上げたのは衣料品で，ニット製品は 76.6%増の 9,380 万ドル，既製服は 27.8%増の 1 億 5,370 万ドルとなった．対日輸出が急増した背景には，日本が 2011 年 4 月から GSP に関する原産地規則を改正したことにある．ニット製品はこれまで (1)紡績，(2)編み立て，(3)縫製の 3 工程が適用条件となっていたが，改正後は輸入糸を使用しても (1)編み立て，(2)縫製の 2 工程を踏めば，特恵関税率が適用されることとなった．同改正はバングラデシュにとって日本市場を開拓するきっかけとなった上，付加価値の高い輸入糸を使用することによって，バリエーションの拡大にも寄与している．日本からの投資は 1,040 万ドルか登録されたか，前年度に比へて 38.4%減となった．登録案件数は 12 件あり，衣料品の製造業か 4 件，皮革製品の製造業か 2 件，IT 関係企業 2 件のほか，ソーラーパネル製造，不動産建設業もそれぞれ 1 件か登録された．投資案件としては，クラボウとマツオカが出資する MK アパレル社(縫製業)が大きく，資本金 551 万ドルで設立された．

表-2　バングラデシュの経済情報と主要品目別輸出入（通関ベース）

主要産業	衣料品・縫製品産業
実質 GDP	1,106 億ドル（2011 年，世銀）
一人当たり GDP	755 ドル（2011 年，バングラデシュ財務省）
	注：バングラデシュの会計年度は 7 月～翌年 6 月末．
経済成長率（GDP）	6.7％（2010 年度，バングラデシュ財務省）
消費者物価指数上昇率	8.8％（2010 年度，バングラデシュ財務省）
労働人口市場（2010 年度，バングラデシュ財務省）	
	5,370 万人農業（48.1％），サービス業（37.4％），鉱工業（14.6％）
GDP 内訳（2009 年度暫定値，バングラデシュ中央銀行）	
	サービス業（49.7％），工業・建設業（29.7％），農林水産業（20.6％）
総貿易額（2010–11 年度，バングラデシュ財務省）	
	（1）輸出　229.2 億ドル
	（2）輸入　336.6 億ドル
主要貿易相手国（2010 年度，バングラデシュ中央銀行）	
（1）輸出　米国，ドイツ，英国，フランス，オランダ，カナダ，スペイン，日本	
（2）輸入　中国，インド，マレーシア，日本，シンガポール，韓国，タイ，インドネシア	
日本の援助実績（2010 年度）	
（1）有償資金協力　549.29（累計総額　7,193.04（E/N ベース））	
（2）無償資金協力　16.48（累計総額　4,689.04（E/N ベース））	

（3）技術協力 24.11（累計総額 585.45（JICA 経費ベース））

	2008／09 年度	2009／10 年度	2010／11 年度
実質 GDP 成長率（%）	5.7	6.1	6.7
貿易収支（100 万米ドル）	△4,710	△5,155	△7,328
経常収支（100 万米ドル）	2,416	3,724	995
外貨準備高（100 万米ドル，年度末）	7,471	10,750	10,912
対外債務残高（100 万米ドル，年度末）	20,856	20,336	21,451
為替レート（1 米ドルにつき，タカ，期中平均）	68.80	69.18	71.17

（単位：100 万ドル，%）

	2009／10 年度	2010／11 年度		
	金額	金額	構成比	伸び率
輸出総額（FOB）	16,204.7	22,924.4	100.0	41.5
衣料品	12,496.7	17,914.5	78.1	43.4
ニット	6,483.3	9,482.1	41.4	46.3
既製服（ニットを除く）	6,013.4	8,432.4	36.8	40.2
ジュート・同製品	788.0	1,114.9	4.9	41.5
ホームテキスタイル	402.5	788.8	3.4	96.0
冷凍食品	445.2	625.0	2.7	40.4
農林産品	242.4	333.9	1.5	37.8
工業製品	311.1	309.6	1.4	△ 0.5
輸入総額（CIF）	23,738.4	33,657.6	100.0	41.8
綿・同製品	2,820.1	4,858.6	14.4	72.3
機械・同部品	2,098.7	2,987.1	8.9	42.3
鉱物性燃料・同製品	1,803.6	2,849.3	8.5	58.0
穀物類	960.7	2,098.2	6.2	118.4
電気機器・同部品	1,213.7	1,766.6	5.2	45.6
鉄鋼製品	1,021.7	1,359.6	4.0	33.1
精油・香料・化粧品類	717.2	1,240.9	3.7	73.0
プラスチック・同製品	826.1	1,129.7	3.4	36.8

〔注〕表 3，4 とも，輸入総額には輸出加工区，借款・贈与分を含む。

〔出所〕表 3，4 とも，バングラデシュ中央銀行および輸出振興庁資料から作成。

1.3.3 気候と水

バングラデシュは北回帰線に近く熱帯性のため，年間を通じて平均気温が高い．

安全な水の供給は大きな問題となっており，多くの水を用いる繊維産業においても，以前は井戸の深さが 100m であったものが，現在では 1,000m に達するケースもある．本プロジェクトは，節水を通して，この問題に対処しようとしたものでもある．

表-3　バングラデシュの平均気温と降水量[7]

	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
最高気温 (°C)	25.4	28.1	32.3	34.2	33.4	31.7	31.1	31.3	31.6	31.0	28.9	26.1
最低気温 (°C)	12.3	14.0	19.0	23.1	24.5	25.5	25.7	25.8	25.5	23.5	18.5	13.7
降水量 (mm)	7.0	19.8	40.7	110.7	257.5	460.9	517.6	431.9	289.9	184.2	35.0	9.4

1.3.4 バングラデシュの環境関連法規[8]

バングラデシュでは，1995年環境保全法(“The Bangladesh Environment Conservation Act, 1995”)および1997年環境保全規定(“The Environment Conservation Rules, 1997”)に基づき，環境・森林省の環境庁が環境行政を実施している．

同規定では，すべての新規産業，活動およびプロジェクトは，環境に及ぼす影響の度合いと実施場所により，Green，Orange A，Orange BとRedカテゴリーに分類され，カテゴリー毎の指針に従って，環境影響調査を実施する．

GreenとOrange Aカテゴリーの案件は，基本的にプロジェクトの概要書と地方自治体の許可書を提出すれば，環境認可証明書(“Environment Clearance Certificate”)を取得できる．書類に不備がなければ，Greenの場合は書類の受理から15日以内，Orange Aの場合は30日以内にECCが発行される．

Orange BとRedカテゴリーの案件は，上記に加え，初期環境調査書(“Initial Environmental Examination”)および環境管理計画書(“Environmental Management Plan”)などを提出する必要がある．IEEの内容によっては，環境影響評価報告書(“Environment Impact Assessment report”)の作成が必要になる．

省エネに関しては，とくに規制は存在しない（隣のインドでは，2012年からPATというエネルギー多消費産業を対象とした（画期的な）省エネ証書取引制度が動き出し，繊維産業も含まれている）．

1.3.5 バングラデシュの繊維産業の事情[9]

1971年の独立以降，バングラデシュの繊維産業は大型国営企業を中心に成長が試みられることとなった．国営のBTMC（Bangladesh Textile Mills Corporation）は当時，世界最大の綿花購入企業として知られた．しかしながら，官僚中心の運営はうまくいか

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[7] 出典：http://www.virtualbangladesh.com

[8] バングラデシュ政府　環境・森林省ホームページ

[9] 日本化学繊維協会ホームページ

ず，市場の動向をつかみきれず発展をみなかった．

1970 年後半になり輸出志向の民営既製服メーカーが台頭し，急速に既製服輸出が拡大した．政府も 1982 年，これまでの国営中心の繊維政策から民間支援に政策を転換し，衣料輸出を中心にバングラデシュの繊維産業は拡大を遂げることとなる．

前述のように，繊維産業は現在，GDP の 10.5%，輸出の 78%を占め，同国経済で非常に重要な位置を占めている．工業付加価値額の約 4 割を占め，約 500 万人（うち 7 割が女性）に雇用を提供している．

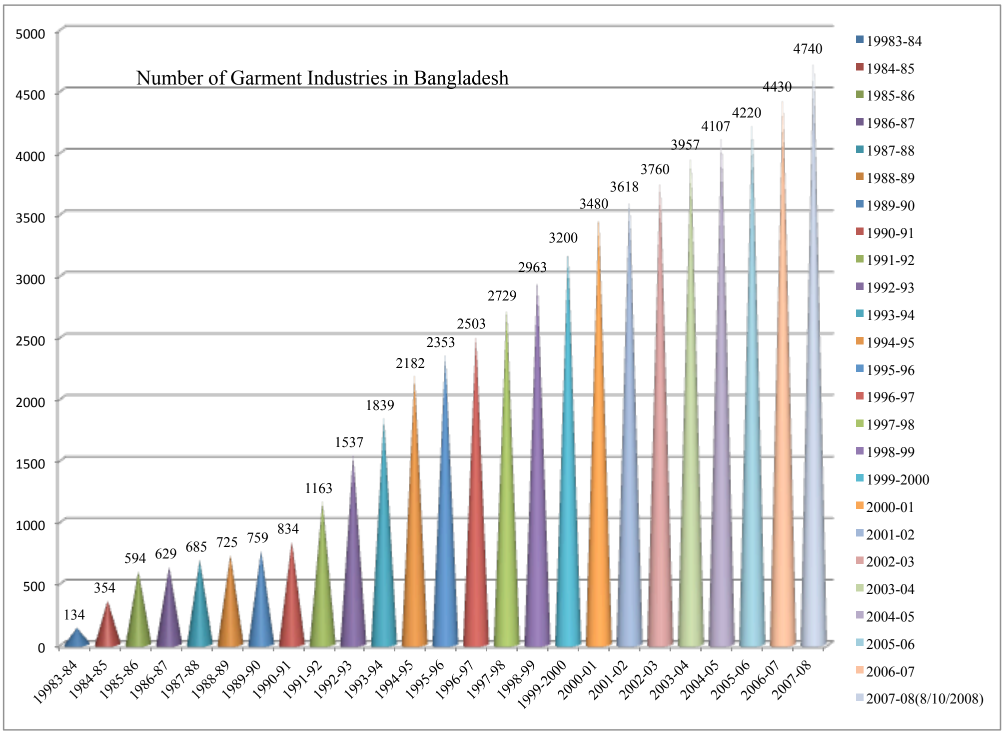

図-2　バングラデシュにおける繊維加工工場の数[10]

1.3.6 バングラデシュの繊維産業における環境・エネルギー事情

繊維産業の急速な成長の伴い，省エネルギー・環境対応が必要とされている．これは，繊維産業には，大量の水が必要となり，各工場で地下水をくみあげて利用しており，繊維産業が集中しているダッカ周辺において，地下水の過剰利用により地下水位低下，特に乾期の終わりの頃には，手押しポンプが枯れて家庭用水が使えなくなると行った問題また地下水位の低下が地盤沈下を起こしているといった報告もある．

さらに，バングラデシュには，電力不足であり，発電エネルギーとして天然ガスが 90％近くを占めており，天然ガスは近隣のインド，パキスタン，タイ，マレーシアと比較して最も安いため需要を促進させる反面，無駄使いの温床にもなっていると言われて

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[10] バングラデシュ衣料品製造業・輸出業協会年報（2011 年）．

いる．大勢の繊維加工工場においても，自家発電装置から主な電力を得ていることが現実である．

政府も電力と天然ガスの供給を輸出の柱産業のために最善を尽くしている一方，最近天然ガスの値上げなどの政策を打ち出している．

要するに，繊維加工産業において，節水・省エネ技術，手法などを推進することは，バングラデシュのサステイナブルで低CO_2型経済発展の実施において，大きな意義を持つことになる．

1.4 バングラデシュのCDMに関する政策・状況等

1.4.1 DNAの設置状況[11]

バングラデシュは2001年10月に京都議定書を批准し，2003年10月に指定国家機関(DNA)を設置した．バングラデシュのDNAはCDMボードとCDM委員会で構成されており，承認手続きは以下の図の通りである．なお，承認の条件として，温室効果ガスの削減だけではなく，持続的発展への貢献も期待されるような案件である必要があると，バングラデシュのCDM政策条文に明文化されている．

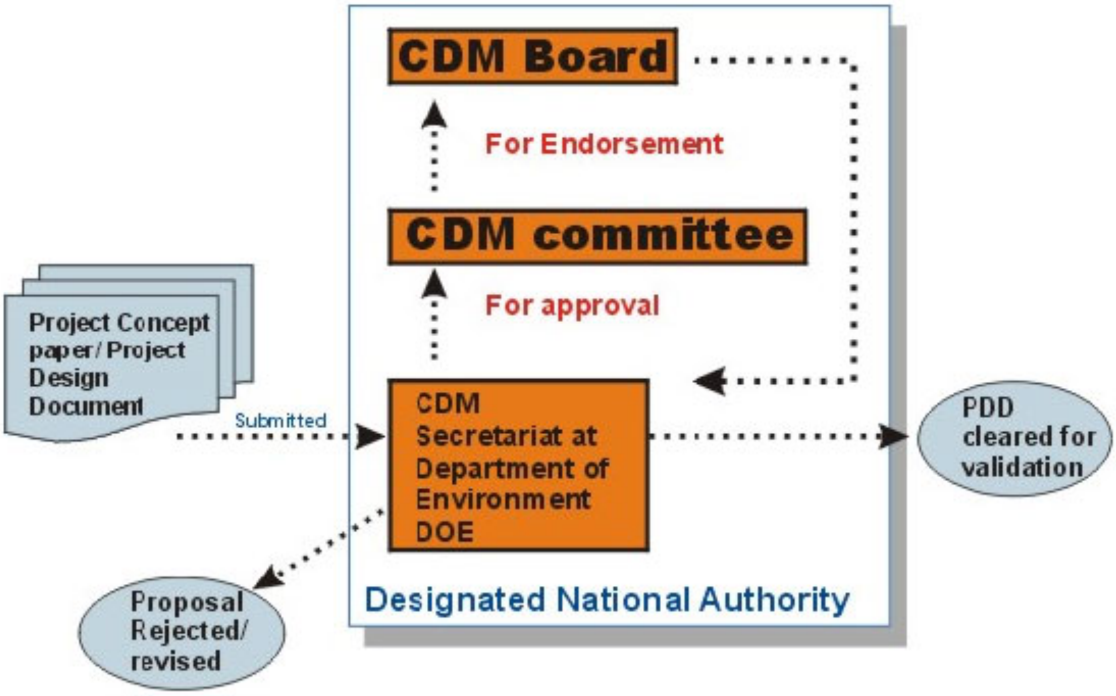

図-3　CDMプロジェクト申請手順

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[11] バングラデシュ政府のCDMサイトおよび公開資料より作成

国家 CDM ボード(National CDM Board)は,

- 理事長: 首相主席秘書官
- 理事会構成員: 環境・森林省, 国家計画委員会(Planning Commission)をはじめとする関連省庁の秘書官
- Member-Secretary: 環境庁 長官(Director General)

から構成されている.

国家 CDM 委員会(CDM Committee)は,

- 委員長: 環境・森林省 秘書官
- 委員会構成員: 環境・森林省, 国家計画委員会をはじめとする関連省庁およびバングラデシュ中央銀行の専門家, 商工会議所連合会, バングラデシュ国立工科大学などの非政府機関の専門家
- Member-Secretary: 環境庁 Director (Tech.)

から構成されている.

1.4.2 CDM 実施状況[12]

バングラデシュは南アジアでは 2 番目に京都議定書を批准したが, 後発開発途上国で排出量が少ないことや, PDD 作成に必要な情報の入手が困難ということもあり, 2012 年 12 月現在, 国連 CDM 登録済案件は 2 件にとどまっている. ただそのうち一件は稼働していない.

表–4 バングラデシュにおける CDM プロジェクト情報

案件名	実施者	案件状況
Composting Project at Matuail Dumpsite, Dhaka	Waste Concern World Wide Recycling B.V	国連 CDM 理事会登録済
Landfill Gas Extraction and Utilization at Matuail Dumpsite, Dhaka	Waste Concern World Wide Recycling B.V	国連 CDM 理事会登録済
Improving Kiln Efficiency in the Brick Making Industry in Bangladesh	Industrial and Infrastructure Development Finance Company Ltd (IIDFC)	国連 CDM 理事会登録済
Improving Kiln Efficiency in the Brick Making Industry in Bangladesh	Industrial and Infrastructure Development Finance Company Ltd (IIDFC)	国連 CDM 理事会登録済

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[12] DNA プレゼンテーション資料, バングラデシュ政府の CDM サイトより作成.

(Bundle-2)		
Installation of Solar Home Systems in Bangladesh	Infrastructure Development Company Ltd. (IDCOL)	国連 CDM 理事会登録済
Improved Cooking Stoves in Bangladesh	グラミン・シャクティ	国連 CDM 理事会登録済
Efficient Lighting Initiative of Bangladesh (ELIB)	Infrastructure Development Company Ltd. (IDCOL)	国連 CDM 理事会登録済
Programme for Promotion of Access to Domestic Biogas in Rural Bangladesh	Infrastructure Development Company Ltd. (IDCOL)	DNA 承認済 有効審査中
Energy and Water Saving Promotion Programme for Textile Dyeing Process of Bangladesh Textile and Garment Industries	Green Project W.S.T	有効審査中
Installation of 30,000 Solar Home Systems (SHS) in rural households	未公表	DNA 承認済 事業開始時期未定
Replacement of 100,000 Incandescent Bulb with Energy Efficient Compact Fluorescent Lamp (CFL) in Rural Bangladesh	SouthSouthNorth Network Netherlands Government	DNA 承認済 事業開始時期未定
Mitigation of GHG Emission through Co-Management of Chunati wildlife sanctuary	未公表	DNA 承認済

2 調査内容

2.1 調査実施体制

本調査の全体の実施体制および各関係者の役割は以下のとおりである.

PEAR カーボンオフセット・イニシアティブは, 調査受託先であり, その役割は:
- 関連文献調査
- 現地調査
- 経済性分析・評価
- PoA-DD および CPA-DD 作成を含む国連審査手続き全般

Green Project W.S.T は, ホスト国でのカウンターパートであり, その役割は:
- 当該 PoA の CME（調整・管理機関）
- プロジェクトにおける基礎情報収集
- 導入技術の推進
- 説明会の開催等

Grameen Knitwear は, 当該 PoA の CPA1 の対象工場であり, その役割は:
- CPA1 の実施
- プロジェクトにおける基礎情報収集
- モニタリングの実施

その他, JQA がバリデーションを実施する.

2.2 調査課題

本調査では, 以下の課題について重点的に調査と検討が行われた.

1. 適用できる技術の把握

バングラデシュの繊維加工業の染色加工プロセスの実態を詳細に把握する（工場オウナーの考え方なども含む）. それと同時に, とくにゼロもしくは低コストでどの技術が適用可能かを, 診断を通じて把握する.

2. CDM 化にあたっての課題

適用する方法論は, AMS-II.D (ver. 12)であり, かなり柔軟な扱いが許されている方

法論となっている．ただ，ベースラインエネルギー消費量に上限があり，また PoA で多様な工場を対象とするため，モニタリングがどの程度可能であるかどうか？という点が，CDM 化した後のモニタリング時点で課題となり得る．

ここでの基本的考え方は，エネルギーマネージメントの一貫としての各種モニタリングの中に，GHG の意味でのモニタリングを埋め込むべき，というものであり，それが現場の実態と合わせて，（モニタリング機器設置の重要性も加味しながら）検討する．

2.3 調査内容

2.3.1 国内調査の概要

本調査実施にあたり必要となる繊維加工産業，特に染色技術関連情報および CDM 関連情報の収集を行った．具体的には，バングラデシュの繊維加工産業における染色技術関連文献，情報を収集するとともに，バングラデシュでの工場での実体を把握するために，日本繊維技術士センター(JTCC)の専門家を訪問し，技術面での相談の上，CPA1 の対象となる工場に対しての調査と診断の依頼をした．また，

2.3.2 現地調査の概要

調査/出張は 3 回実施した．概要は以下の通りである．

表-5 第 1 回現地調査内容

月日	訪問先
8月31日	成田→ダッカ市内宿泊
9月1日	資料整理，ダッカ着（松尾）
9月2日	午前：現地カウンターパートナー（WST，Grameen Knitwear 及び Landmark）協議．紡績工場燃料消費量，水消費量測定，診断内容，項目の説明と議論．午後：Landmark 工場視察，データ入手ための測定器械設置ポイントのチェック及び関連事項に関する協議．
9月3日	Landmark 工場において，測定，診断の実施．
9月4日	Landmark 工場において，測定，診断の実施．
9月5日	Landmark 工場において，測定，診断の実施．
9月6日	午前：データ整理．午後：Landmark 工場測定，診断結果の発表．

９月７日	資料整理，
９月８日	資料整理
９月９日	Grameen Knitwear 工場において，測定，診断の実施．
９月１０日	Grameen Knitwear 工場において，測定，診断の実施．
９月１１日	Grameen Knitwear 工場において，測定，診断の実施．
９月１２日	Grameen Knitwear 工場において，測定，診断の実施．
９月１３日	午前：データ整理．午後：Grameen Knitwear 工場測定，診断結果の発表．
９月１４日	ダッカ－バンコク－東京
９月１５日	成田着

表-6 第2回現地調査内容

月日	業務内容
11月3日(土)	羽田空港－バンコク－ダッカ
11月4日(日)	午前：10:30～13:30 訪問先：W.S.T.のオフィス（ダッカ） 業務内容：会議準備状況の確認及び染色機メーカーからの専門家と染色過程における水・蒸気消費量の計算方法について協議． 参加者： バングラデシュ側：Mr. Herman Freericks (Thies) Mr. Thomas Mende (Thies) Mr. Kauser Bhuiyan (W.S.T) Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) 日本側：ゴジャシ 午後：14:30~17:30 訪問先：会議場 業務内容：会議場の確認 参加者： バングラデシュ側：Mr. Arman Islam (W.S.T.)

	Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) その他のW.S.T 及びGrameen KnitwearとLandmarkの代表 日本側:ゴジャシ
11月5日 (月)	午前:10:30～13:00 訪問先:Lotus Hall, Uttara Club, Dhaka 業務内容:利害関係者会議へ参加 参加者: バングラデシュ側:Vice president of Bangladesh Garment Manufacturers and Exporters Association (BGMEA) Grameen Knitwear and Landmarkの代表 そのたの紡績工場代表者 染色機メーカー代表者 など50名以上 日本側:ゴジャシ
11月6日（火）	10:30～17:30 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容:会議の結果の整備及び今後の予定確認 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam （W.S.T.） 日本側：ゴジャシ
11月7日（火）	ダッカ～バンコク
11月8日（木）	成田着

表-7 第3回現地調査内容

月日	業務内容
1月5日(土)	羽田空港ーバンコクーダッカ
1月6日(日)	9:00～16:30 訪問先：Grameen Knitwear工場（ダッカ郊外） 業務内容：CPA1 の対象である工場の事情確認とデータ収集 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Mr. Suvro Dev Saha (W.S.T.)

	Grameen Knitwear 工場関連スタッフ 日本側：松尾，ゴジャシ，古屋，小林
1月7日 (月)	午前：9:00～12:00 訪問先：United Power Generation and Distribution Company Ltd. 業務内容：排出係数のための燃料消費量及び発電量データの確認 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側：松尾，ゴジャシ，古屋，小林 午後：13:00～17:00 訪問先：DEPZ Water Supply System及びDEPZ Central Effluent Treatment System 業務内容：水供給システム（ポンプなど）の運営状況と関連データの確認 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側：松尾，ゴジャシ，古屋，小林
1月8日（火）	午前：9:00～11:30 訪問先：W.S.T.での染色剤，薬品生産者代表の面談 業務内容：各染色過程における染色剤，薬品などに関する情報の確認 参加者： バングラデシュ側：Dystar，Clariant (Bangladesh) Ltd）の代表者 午後：13:00～15:00 訪問先：Japan Textile Products Quality and Technology Center (QTEC) Dhaka La 業務内容：プロジェクトに対して，専門家的な意見の収集. 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) (QTEC)の専門家 日本側：松尾，ゴジャシ，古屋，小林
1月9日（火）	午前：9:00～11:30 訪問先：Bangladesh Garment Manufacturers & Exporters

	Association (BGMEA) 業務内容：バングラデシュ紡績業界事情などの確認 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) BGMEA の関連スタッフ 午後：13:00～17:00 訪問先：Landmark Factory 業務内容：今後の CPA の対象となる工場の事情確認 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) 工場関連スタッフ 日本側：松尾，ゴジャシ，古屋，小林
１月１０日（木）	午前：9:00～11:00 訪問先：W.S.Tオフィス 業務内容：Closing meeting 午後：ダッカ空港 ダッカ～バンコク～成田
１月１１日（金）	成田着

2.3.3 調査課題についての調査方法と内容

[1] 応用技術に関する調査

繊維産業の工場における「染色加工プロセス」は，準備工程から仕上げ工程までの一般的なプロセスを含み，おおむね以下の図のように表される．

下図からわかるように，非常に多くの要素プロセスにおいて，熱やスチームを用いた(化学的あるいは物理的)加工 → 水洗/湯洗 → 乾燥というエネルギーをかなり使うプロセスがセットで介在する．また，染色プロセス自体以外にも多くの準備プロセスや仕上処理プロセスにおいて，大量の水を使うプロセスとなっている．また多くの薬剤が用いられる．

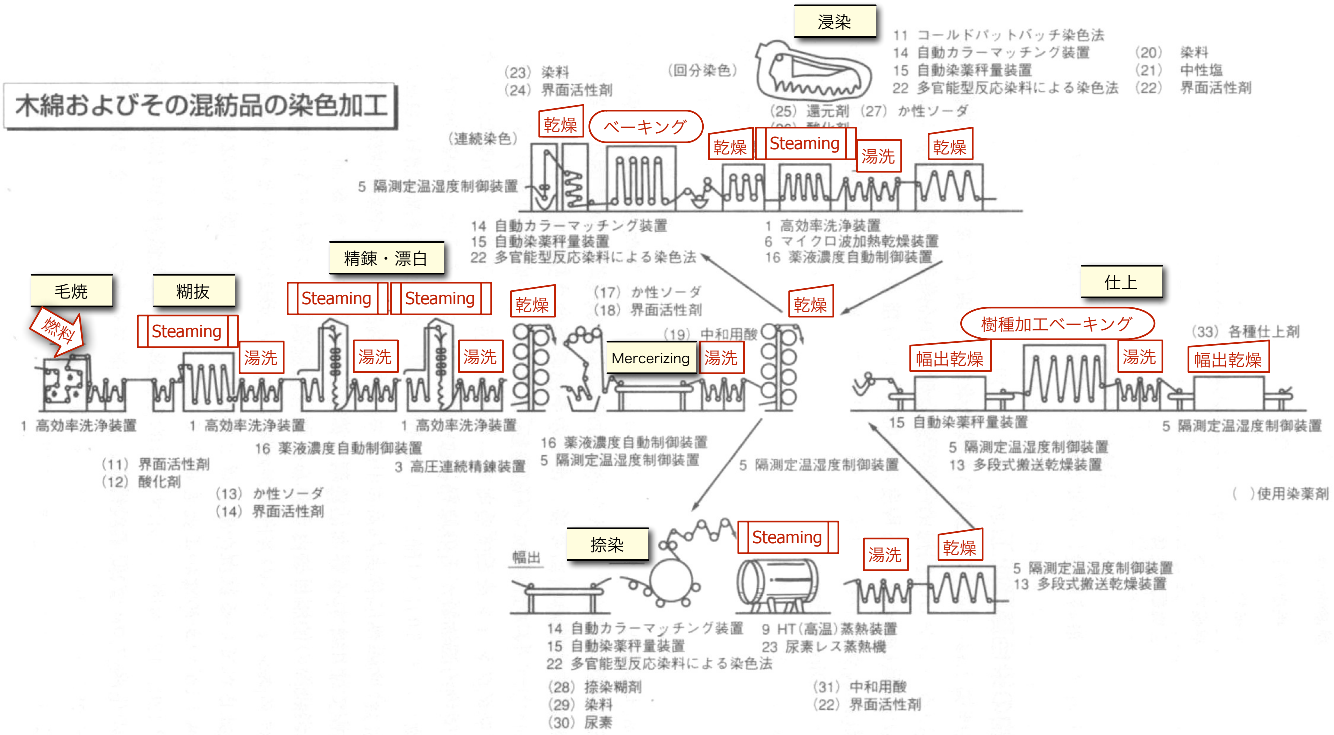

図-4　繊維加工工場における染色加工プロセス

当該 PoA においては,

(a)　とくに水利用に関係した点から，染色技術「そのもの」を節水型，省エネ型，低薬品型の技術に転換する「化学的省エネ」

(b)　(水利用とは直接関係ない形の)熱エネルギーの「物理的省エネ」(乾燥プロセス等)

の，2 つのタイプの技術を採用することが想定できる．

前者 (a) は，いわゆるユーティリティーの省エネタイプではなく，生産技術そのものを改変するという(いわば一段階進んだ)クリーナープロダクションタイプの省エネである．当該 PoA では，こちら側を対象とする．

後者 (b) は，従来型省エネの範疇であるが，投資コストのかかる省エネ型機器導入よりもまず，エネルギーマネージメントだけでもかなりの省エネが可能となる．

個々の工場での活動を CPA とするが，各 CPA で実際にどの技術を採用するか？という点は，実際に工場での診断を実施して，工場の実態，要するコスト，工場側のニーズなどを把握して，決定できる．このために，日本の日本繊維技術士センター(JTCC)の専門家に依頼し，現地調査を行った．

[2] CDM 化にあたって，特にモニタリングに関する調査

バングラデシュの繊維加工工場で，エネルギー管理に必要となる測定機器などがほとんど設置されていない．

一方，モニタリングにおいて測定機器の設置は，重要である．しかし，バングラデシュの紡績工場での現実から見るとすべての項目（とくに蒸気もしくはその燃料の染色用途部分）に対して，方法論で要求されている直接測定を行うことは，大変困難である（測定器も 100 万円以上と非常に効果であり，個々の（複数の）染色機に設置するのは非現実的である）．

したがって，比較的容易な染色工場での染色機ごとの電力消費量は，直接測定する一方，蒸気の消費量に対して，直接測定の難度が高く，染色機が出力する実績の染色チャートを基づいて計算することを想定している（染色機のアウトプットとして実績値が得られればそれを利用．それが難しければ設計（プログラム）を利用）．

この，実態と方法論とのギャップ（および方法論の理論的問題[13]）に関して，9 月 23 日に SSC WG への Clarification を提出した(SSC_665[14])[15]

2.3.4 調査課題についての成果

1. 応用技術に関する調査

CPA1 の対象である Grameen Knitwear 工場と Landmark 工場への審査の結果，二つの工場の事情には大分差があったが，「物理的省エネ」の余地はかなりあった．しかし，CME である W.S.T は，現時点で，(b)の採用には関心を持たないため，PoA において，当面は (a)をメインとする．すなわち，一連の染色プロセスのうち，染色機のみを対象とする．

2. CDM 化にあたって，特にモニタリングに関する調査

上述のモニタリングに関する clarification の点について，SSC WG から以前提出した確認事項についての電話会議の要請があり，1 月 11 日 17:30（日本時間）に電話会議が行われた．その結果，

(a) 方法論でのエネルギーの直接測定という記述は，蒸気量また温度などの測定から熱エネルギーを計算すると解釈できるということの確認ができた．また，AMS-I.D や AMS-II.K におけるモニタリング要件を参考できるということとなっ

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[13] エネルギーの「直接測定」は，理論的にかなりむつかしい．通常は複数の物理量を測定して，（物理法則を用いた）計算によって（測定機器によっては自動的に）求める．

[14] http://cdm.unfccc.int/methodologies/SSCmethodologies/clarifications/18616.

[15] 非常にタイミングが悪く，SSC WG が半年間開かれない時期と重なったため，回答を得るまでに 7 ヶ月を要することとなったが，事務局がこの点を考慮してくれて，電話会議が行われた．

た.

(b) 染色機における蒸気の量に対して，実測することには難度があることなら，保守性を保障できるような実績チャートから読み取る方法を提案することも可能であるという確認ができた. ただし，この場合，申請上に時間がかかる可能性が高い.

となった.

これの結果を踏まえて，W.S.T との相談の上，サンプル手法でモニタリングを行うことにし，染色機に測定器が付いてない場合，（外部あるいは内部に）測定器を設定することにした.

サンプリングに関して，普段工場は，注文をベースに，事前に材料. 色の組み合わせごとの染色レシピとその数を用意する. この同じ組み合わせに相当レシプの中からのサンプルバッチを対して，測定を行う. また，サンプリングは，90/10 の信頼度を保証する.

3 調査結果

以下に関して，添付の PoA-DD には，より詳細に記載されているためそちらも参照されたい.

3.1 ベースラインシナリオおよびプロジェクトバウンダリーの設定

3.1.1 プロジェクト実施サイトの概要

本可能性調査の対象となる PoA は，バングラデシュ国全体の繊維加工工場を対象に W.S.T の節水・省エネ技術の推進を図る.

本 PoA の最初の CPA として，Grameen Knitwear（GK）工場を対象とする. Grameen Knitwear は，グラミングループの一員であり，1997 年に設立され，その工場はダッカ輸出加工区（DEPZ）にある.

GK は，主にニットとその他の繊維製品を生産しており，5 台の Sclavos 製染色機で，一日 8 トンの染色能力を持っている. GK における電力は，DEPZ に電力提供している United Power Generation and Distribution Company, Ltd.から，水も，DEPZ の水供給システムから取得している. GK の位置を以下の図で示す.

図-5　GK の工場の位置

DEPZ (23°56'44"N 90°16'47"E)に関する情報：

所在地：	Savar（ダッカ市中から35キロ，国際空港から25キロ）
区面積：	143.84ヘクタール(355.34エーカー)
産業区画数：	372
各区画面積：	2,000平方メートル
工場建物面積(標準)：	76,000平方メートル
倉庫面積：	2,356 平方メートル

3.1.2 プロジェクト実施サイトにおける水及びエネルギーの事情

下記の図は GK 工場の平面図である．上述のように GK には，5 台のジェット染色機 (Sclavos 製)があり，このタイプの染色機は，1:8 の溶比[16]で，overflow rinsing (no stop process for drain and fill)式で染色が行われる．染色用の蒸気は，工場にある 4 つのボイラーのうち 2 つの専用ボイラーから提供されている．

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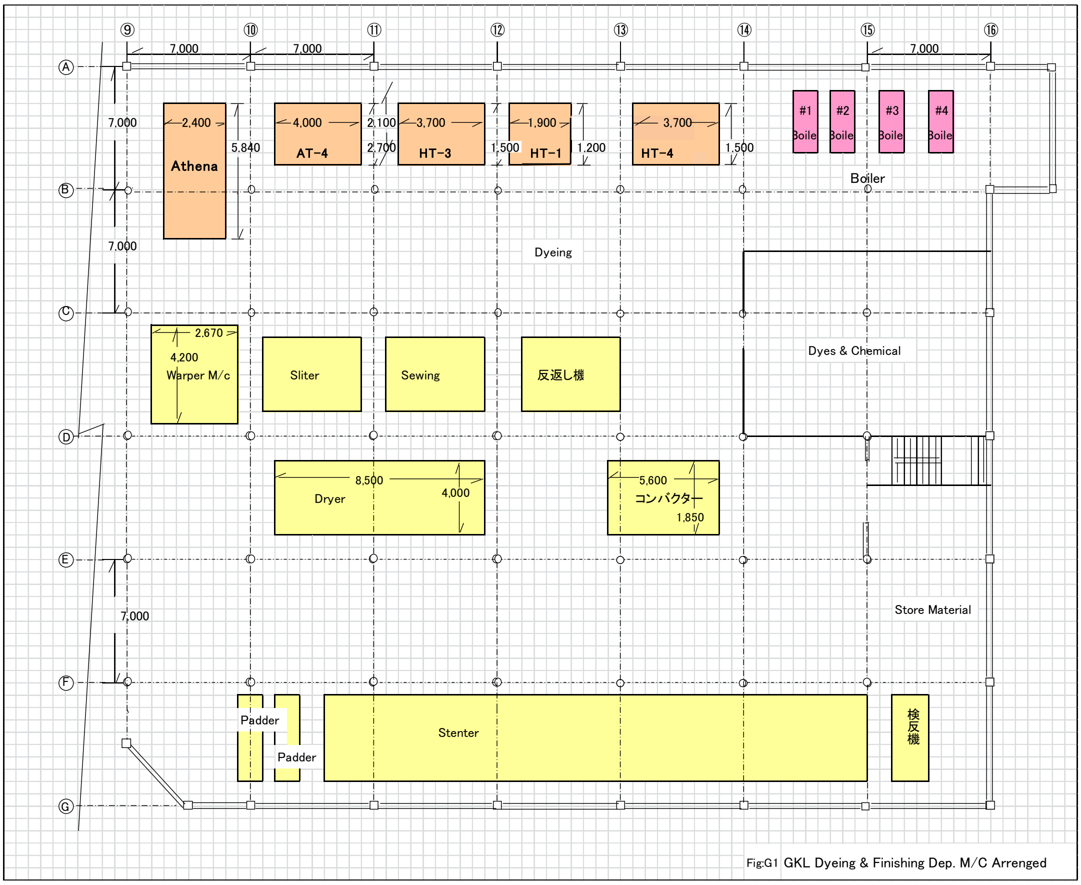
[16] 1kg の織物のために 8kg の水を必要とする



図−6　GK工場の平面図

GKの染色機とボイラーに関する情報は，下記のとおりである．

ATHENA	VAT-4	VHT-3	VHT-1	VHT-4
1000kg	720kg	540kg	180kg	720kg
Jet HT	Jet AT	Jet-HT	Jet-HT	Jet-HT
CVC/PET/C100	Cotton only	CVC/PET/C100	CVC/PET/C100	CVC/PET/C100

図-7　GKの工場での染色機

表-9　GKの工場にあるボイラー情報

Item	Unit	Boiler 01	Boiler 02	Boiler 03	Boiler 04
Manufacture year:	-	1998	1998	2003	2006
Brand name	-	COCHRAN	COCHRAN	COCHRAN	COCHRAN
Origin	-	UK	UK	UK	UK
Types	-	Fire tube	Fire tube	Fire tube: Diesel fuel	Fire tube: Diesel fuel
Steam Generating Capacity	Kg/hr	3,630	4,535	1,500	5,000
Design pressure	bar	12	12	12	12
Working Pressure	bar	10	10	10	10
Fuel (Gas) Consumption	M3/hr (L /hr)	259	324	11	(353)
	M3/Day (L./month)	6,206	7,781	1,114	(3,528)
Remarks				Operation time（10hr/day) (For garment ironing)	For back up (Maximum operation time is 10hr/month)

GKの工場における水およびエネルギーの流れは，下記のようになっている．

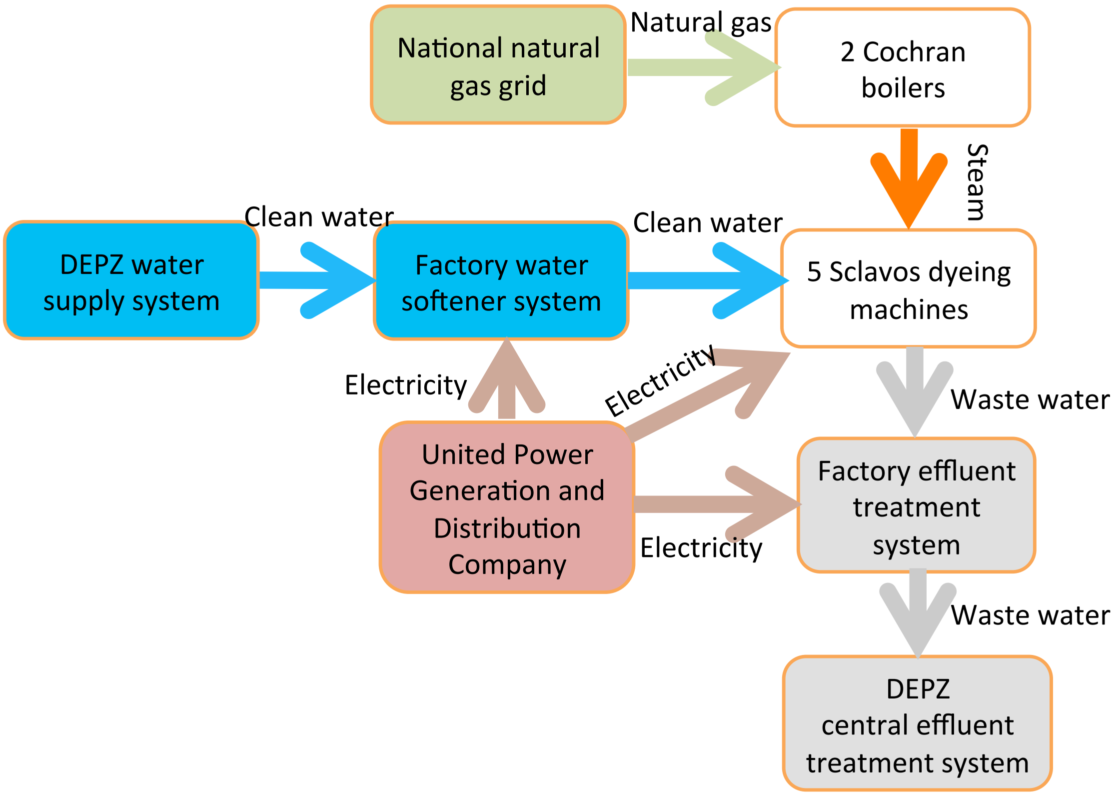


図-10　GKの工場におけるエネルギー及び水の流れ

染色は，その材料，色などによって，適用する手法，かかる時間や使用する化学薬品の量などが異なる．GK工場では，以前から，コットンのために反応染色(direct dyeing)，CVC (chief value cotton, コットン50％以上の混合)のために分散染色(disperse dyeing)+反応染色，ポリエステルのためには分散染色が用いられてきている．また，低品質のコットン糸が使われており，着色のための化学薬品などと水の消費量の高くなることの一つの原因にもなっている．

GK工場の2011年における染色生産量とそのための水及びエネルギーの消費量は，下記の表となっていた．

表-10 GKの工場の水及びエネルギー消費量事情

Month	**Production** (Kg fabric)	**Water Consumption** (m3)	**Power Consumption (kWh)**	**Gas Consumption (m3)**
January	172,115			
February	108,410			
March	186,403			
April	230,283			
May	212,112			
June	265,858			
July	150,854			
August	278,764			
September	185,632			
October	240,150			
November	224,098			
December	280,302			
Total	2,534,981	269,357	1,897,322	3,275,639

ここでの生産実績は，コットン，CVCおよびPolyesterをあわせた結果で，実際は，異なる材料の単位あたりにおける水消費量，エネルギー消費量はこれらで異なる．

GK工場での既存技術では，100%の濃いコットンの場合，水および蒸気消費量は，80 liter水/kg fabric，6.5 kg蒸気/kg fabricであり，一方，CVCの場合，130 liter水/kg fabric，10 kg蒸気/kg fabric[17]という数字であった．

前述したようGK工場は，工場用水をDEPZの水供給場から得ており，工場で利用する前に工場にある水処理システム（下記の図-11参照）を経て提供することになっている．また，工場からの排水も，DEPZのETP (effluent treatment plant)に排出する前，工場のETPで，前処理されている（図-12参照）．

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[17] W.S.T の調査より．

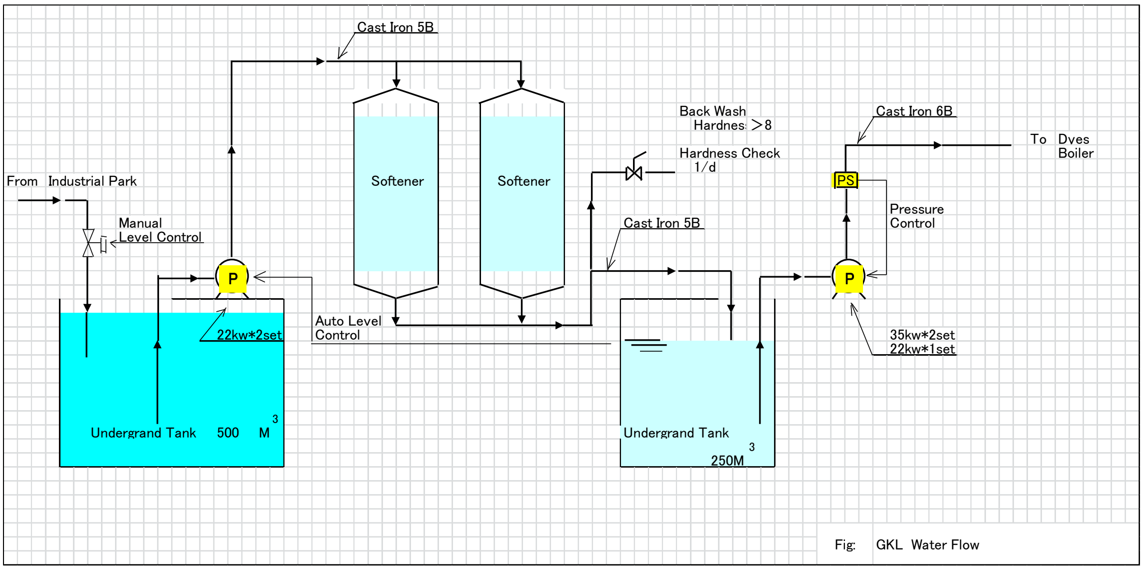

図-11 GKの工場の水処理システム

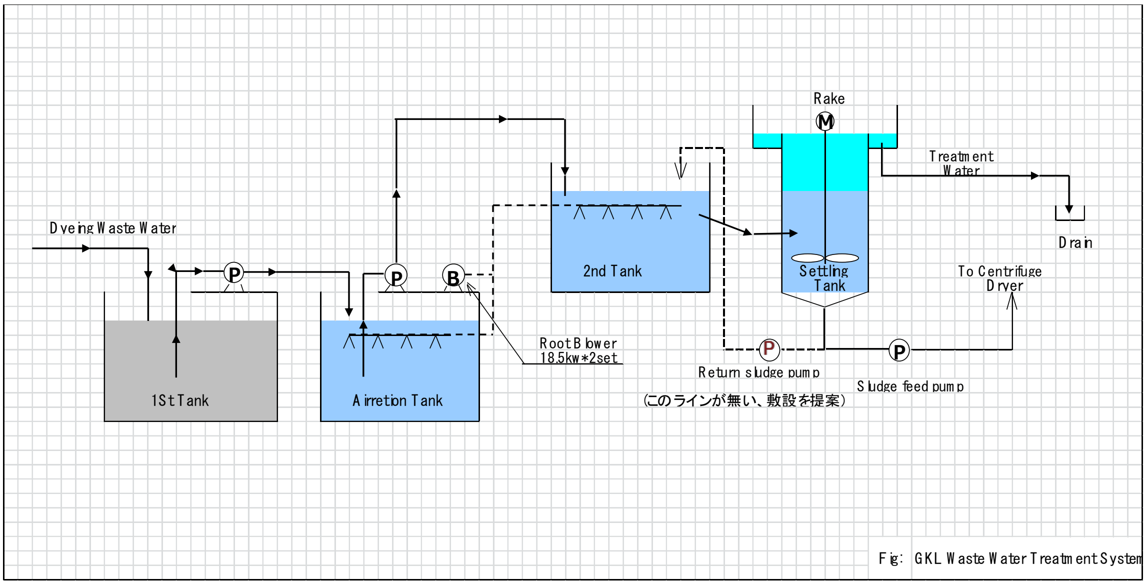

図-12 GKの工場の排水処理システム

3.1.3 プロジェクト適用技術

前述のように，GKの工場（およびバングラデシュのほとんどの繊維加工工場）では，既存の染色技術は，反応染色（100%コットン），分散染色（disperse dyeing）+反応染色（CVC）及び分散染色（Polyester）であったが，当該プロジェクトにおいて，コットン染色のために直接染色，新世代(new generation)反応染色，CVCのためにone batch染色，polyesterのためにcationic dyesの技術を導入する．また，高質のコットン糸の使用を推奨する．以上の技術の推進において，W.S.T が各工場に対して，事前調査・診断を行い，適正な技術を推奨することになっている．

3.1.4 方法論と適用性評価

当該PoAにおいて，AMS-II.D (ver. 12) “Energy efficiency and fuel switching measures for industrial facilities” を使用する. この方法論は非常に広範囲に柔軟な運用が可能である. その一方で，過去実績を，原単位でなく，エネルギーの絶対消費量の形で表現するため，生産量が増えていく傾向のある途上国の工場にとって，非常に不利な方法論設定となっている.

この問題を回避するため，また染色プロセスは連続的に同じものを生産する方式ではないため，AMS-II.Dにおいて，実績を測定する「キャンペーン」（＝バッチ）概念の導入と，生産キャパシティーが，製造装置に紐付いていないことの確認をSSC WG/CDM理事会に対して行った. その結果，下記のような提案内容が，SSC WGに容認された.

> *10. In case the energy efficiency measures are introduced to several batch processes, the processes shall be categorized into several ones whose characteristics, in terms of energy, are different (by product-type, applied technology, etc.). Then, define the campaign as the unit cycle of operation of the batch process as the basis of evaluating historical energy consumption for baseline and also define the production capacity for the batch process (e.g., ton/day).*

本PoAでは，基本的に一つのCPAは，一つの工場を対象とする.

また，各CPAにおける「既存のエネルギー消費量の実績」を，染色機に行われる「染色1バッチに必要となるエネルギー（電力＋蒸気）消費量」で『定義』する. そしてこの実績を把握するために“baseline measurement campaign”の実施[18]を行うこととなる（染色機以外の染色プロセスに関しても技術が導入される場合に適用できる形には拡張しようと思っていたが，モニタリングの記述などがやや複雑になり，実質的にその可能性が当面は少ないので，単純化のために拡張は行わない予定である）.

さらに，染色におけるエネルギー消費量は，機械，繊維の素材及び繊維の色によって異なるため，バングラデシュでの紡績工場で一般とされている

「色（薄，中，濃） × 素材（綿，混紡，ポリエステル）」

という「9 つの組み合わせ」を分類として定め，事業を実施する前に，各工場において

「バッチ単位」，「染色機ごと」

に，個々の組み合わせのエネルギー消費量を把握するとなる（＝ベースラインエネルギー消費量）.

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[18] 触媒を用いた硝酸 N_2O 破壊プロジェクトの方法論で，この概念が用いられている.

対象となる技術いわゆる染色機での処理手法の変更は，機械・機器などの交換・改善などを行わないため，染色機などの“remaining lifetime”を論証する必要性はない．すなわち，染色機自体が交換される（染色機の実質的寿命はメインテナンスを行っていれば，30 年以上である）ことをモニターしておき，その時点までの削減量をクレームすればよい．

モニタリングに関して，電力測定器などの設置によって，機械ごとの電力消費量の直接測定は可能であるが，蒸気量を測定器で直接測定することは，（不可能ではないが）バングラデシュの現実から見ると難度やコストが高い[19]．そこで，蒸気量の把握に関して，染色機における染色プロセス（温度，温水量，時間等のチャート）の実績図に基づいて保守的な試算することが妥当だと思われる．しかし，AMS-II.D には，直接測定が要求[20]されており，この件に対しての確認が必要となる．

蒸気エネルギー消費量に関しては，前述の SSC WG/CDM 理事会に対する clarification[21]結果が 4 月になってしまうため，当面は W.S.T メンバーによる蒸気流量計を用いたサンプリング手法を用いることで対応することを想定していた．ただこの場合も，蒸気のパイプに（断熱剤を剥離し）物理的に穴を空け，暫定的に流量計を設置するなどの措置が必要で，危険性と共に，かなり負担の大きなモニタリングとなってしまうため，なんとか SSC WG/CDM 理事会に，染色カーブを用いて理論計算で求める方法を認めてもらうようにした．
半年を超える期間を指摘したところ，SSC WG から提出した確認事項についての電話会議の要請があり，1 月 11 日 17:30（日本時間）に電話会議が行われた．その結果，

(a) 方法論でのエネルギーの直接測定という記述は，蒸気量また温度などの測定から熱エネルギーを計算すると解釈できるということの確認ができた．また，AMS-I.D や AMS-II.K におけるモニタリング要件を参考できるということとなった．

(b) 染色機における蒸気の量に対して，実測することには難度があることなら，保守性を保障できるような実績チャートから読み取る方法を提案することも可能であるという確認ができた．ただし，この場合，申請上に時間がかかる可能性が高い．

となった．
この結果を踏まえて，W.S.T との相談の上，サンプル手法でモニタルングを行うこと

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[19] 蒸気流量計は 100 万円程度とかなり高価で，複数の染色機に搭載することは非現実的である．

[20] 方法論で要求されている「エネルギー消費量の直接測定」は，ある意味では不可能（すなわち方法論の要求はナンセンス）で，蒸気のエネルギー消費量に関しても流量や温度などのエネルギーとは異なる複数のパラメタから「計算」で求めることになる．

[21] Clarification においては，“Metering the energy use of the industrial or mining and mineral production facility, processes or the equipment affected by the project activity;”を，“Metering the energy use directly or indirectly by calculation in an accurate or conservative manner through other related physical quantities in the industrial process based on the relevant theory of the process.”と改訂することを，理由と共に要求した．

にし，染色機に測定器が付いてない場合（外あるいは内部に），測定器を設定することにした．

具体的には，染色機に測定機器（外付けの機器あるいは内部の機器が機能してない）がない場合，染色機ごとに測定器を設置し，実測を行う．外付けの測定器は，電力計，蒸気及び水流量計のことであり，移動式の測定器には，コストが高いかつ移動式の蒸気流量計は，染色機に機能的に合わないという技術的な面での問題も明らかになり，結果として，固定の測定器を設置することを決定した．

だだ，染色機に内部のモニタリング機器が設置済みでかつ順調に機能している場合，その記録データを用いる．

この方法論の適用可能性の論証を，下記の表に示す（CPA 1 の場合）．

表-11　方法論適可能用性論証（AMS-II.D は主要関連部分）

方法論の条件	論証
5. This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility/ies. This category covers project activities aimed primarily at energy efficiency;	5．当該 CPA は，繊維加工工場（GK の工場）の染色過程において省エネ技術を推進する．
6. This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g., electricity and/or fossil fuel consumption).	6．染色過程における電力消費量と蒸気の消費量は，適正なポンとに設置される測定器などによって想定と記録できる．
7. This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	7．当該 CPA は，染色機のみを対象とする．導入技術の範囲は明確にで，影響は区別可能である．
8. The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GW_eh per year. A total saving of 60 GW_eh per year is equivalent to a maximal saving	8．クレジット期間中に，年ごとの省エネルギー総量は，180 $GW_{th}h$ を超えてはいけない．ちなみに，180$GW_{th}h$ を超えた部分は，削減量に算入しない．当該 CPA の最初の年の省エネルギー総量の推

of 180 $GW_{th}h$ per year in fuel input.	定値は，15 $GW_{th}h$/year である．

上記から，方法論の適用条件は満たされており，本方法論は，当該 PoA の CPA に適用できる.

なお，これらの用件は，PoA-DD の段階で示せるものではないものが多く，CPA の inclusion の際の判断条件である eligibility criteria（下表を参照）として，PoA-DD には記述される：

表-12 PoA の適格性要件

No	**Requirements for Eligibility Criteria**	**Eligibility Criteria**	**Conformity Yes or No**
A	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA.	A.1 A CPA targets a textile and garment factory in Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
		A.2 The name and the address of the factory are defined	Each CPA will demonstrate the conformity of the eligibility criteria
B	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo)	B.1 A CPA is a new project which is not registered large scale CDM or SSC-CPA in the other PoA	Each CPA will demonstrate the conformity of the eligibility criteria
		B.2 There is unique identification of the target factory	Each CPA will demonstrate the conformity of the eligibility criteria
C	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	C.1 Is it possible to submit specification of technology/measure when the DOE validates or verify?	Each CPA will demonstrate the conformity of the eligibility criteria
D	Conditions to check the start date of the CPA through documentary evidence;	D.1 The start date of a CPA is not, or will not be, prior to the commencement of validation of	Each CPA will demonstrate the conformity of the

		the PoA.	eligibility criteria
E	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs;	E.1 Does a CPA meet the applicability and other requirements of AMS- II.D as described in PoA-DD section B.3.	Each CPA will demonstrate the conformity of the eligibility criteria
F	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality	F.1 The achieved energy saving of a CPA at a scale of no more than 60 $GW_{th}h$ per year	Each CPA will demonstrate the conformity of the eligibility criteria
G	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	G.1 A CPA performs local stakeholder consultation before the inclusion of SSC-CPA.	Each CPA will demonstrate the conformity of the eligibility criteria
		G.2 A CPA does not need to performs the environmental impacts analysis according to the regulation of Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
H	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;	H.1 A CPA does not use any fund from Annex I parties	Each CPA will demonstrate the conformity of the eligibility criteria
		H.2 If a CPA uses a fund from Annex I parties then it does not result in a diversion of official development assistance	Each CPA will demonstrate the conformity of the eligibility criteria
I	Where applicable, target group (e.g. domestic/commercial/ industrial, rural/urban, grid-connected/off-grid) and distribution mechanisms (e.g. direct installation)	I.1 Not applicable	Not applicable
J	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard	J.1 A CPA-DD applies 95/10 (confidence /precision) for any necessary survey according	Each CPA will demonstrate the conformity of the eligibility criteria

	from the Board pertaining to sampling and surveys;		
K	Where applicable, the conditions that ensure that CPA in aggregate meets the small-scale or micro-scale threshold criteria and remains within those thresholds throughout the crediting period of the CPA	The aggregate energy savings by a CPA does not exceed the equivalent of 180 $GW_{th}h$ per year	Each CPA will demonstrate the conformity of the eligibility criteria
L	Any SSC-CPA included in the PoA is not a de- bundled component of another CDM programme activity (CPA) or CDM project activity	L.1 Is a CPA confirmed to a single project, which is not a de-bundled component of another large-scale CPA or CDM project activity as per the latest guidance given in CDM EB?	Each CPA will demonstrate the conformity of the eligibility criteria
M	Crediting period of any CPA does not exceed the end date of the PoA.	M.1 Is the crediting period of a CPA is within the crediting period of the PoA?	Each CPA will demonstrate the conformity of the eligibility criteria

CPA1 が PoA の eligibility criteria を満たす状況は，以下となる.

表-13 CPA の適格性条件を満たす状況

No	Requirements for Eligibility Criteria	Eligibility Criteria	Conformity Yes or No
A	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA.	A.1 A CPA targets a textile and garment factory in Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
		A.2 The name and the address of the factory are defined	Each CPA will demonstrate the conformity of the eligibility criteria
B	Conditions that avoid double counting of emission reductions like unique identifications of	B.1 A CPA is a new project which is not registered large scale CDM or SSC-CPA in the other PoA	Each CPA will demonstrate the conformity of the

	product and end-user locations (e.g. programme logo)		eligibility criteria
		B.2 There is unique identification of the target factory	Each CPA will demonstrate the conformity of the eligibility criteria
C	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	C.1 Is it possible to submit specification of technology/measure when the DOE validates or verify?	Each CPA will demonstrate the conformity of the eligibility criteria
D	Conditions to check the start date of the CPA through documentary evidence;	D.1 The start date of a CPA is not, or will not be, prior to the commencement of validation of the PoA.	Each CPA will demonstrate the conformity of the eligibility criteria
E	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs;	E.1 Does a CPA meet the applicability and other requirements of AMS- II.D as described in PoA-DD section B.3.	Each CPA will demonstrate the conformity of the eligibility criteria
F	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality	F.1 The achieved energy saving of a CPA at a scale of no more than 60 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
G	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	G.1 A CPA performs local stakeholder consultation before the inclusion of SSC-CPA.	Each CPA will demonstrate the conformity of the eligibility criteria
		G.2 A CPA does not need to performs the environmental impacts analysis according to the regulation of Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria

H	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;	H.1 A CPA does not use any fund from Annex I parties	Each CPA will demonstrate the conformity of the eligibility criteria
		H.2 If a CPA uses a fund from Annex I parties then it does not result in a diversion of official development assistance	Each CPA will demonstrate the conformity of the eligibility criteria
I	Where applicable, target group (e.g. domestic/commercial/industrial, rural/urban, grid-connected/off-grid) and distribution mechanisms (e.g. direct installation)	I.1 Not applicable	Not applicable
J	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys;	J.1 A CPA-DD applies 95/10 (confidence /precision) for any necessary survey according	Each CPA will demonstrate the conformity of the eligibility criteria
K	Where applicable, the conditions that ensure that CPA in aggregate meets the small-scale or micro-scale threshold criteria and remains within those thresholds throughout the crediting period of the CPA	The aggregate energy savings by a CPA does not exceed the equivalent of 180 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
L	Any SSC-CPA included in the PoA is not a de- bundled component of another CDM programme activity (CPA) or CDM project activity	L.1 Is a CPA confirmed to a single project, which is not a de-bundled component of another large-scale CPA or CDM project activity as per the latest guidance given in CDM EB?	Each CPA will demonstrate the conformity of the eligibility criteria

M	Crediting period of any CPA does not exceed the end date of the PoA.	M.1 Is the crediting period of a CPA is within the crediting period of the PoA?	Each CPA will demonstrate the conformity of the eligibility criteria

3.1.5 ベースラインシナリオ

AMS-II.D (version 12)の規定するところでは，当該 PoA における CPA のベースラインは，各工場は，染色工程において従来型の染色手法を用い続け，CDM とならない場合には，そのファシリティーが使い続けられる限り，エネルギー絶対量として過去の平均水準で，水とエネルギーを消費し続けると想定することになる.

バングラデシュの繊維加工工場で，最も支配的な染色技術と選ばれているもの[22,23]は，反応染色，分散染色（polyester の場合）であり，したがってこの現状の技術が選択し続けることが，ベースラインシナリオと想定できる.

本 PoA の地理的バウンダリーは，バングラデシュ全土であり，バングラデシュにある染色過程を含む繊維加工工場の全部に拡大することを想定している．一方，個々の CPA に関しては，各工場における染色過程での染色機また関連の活動の影響範囲までを含むエリアと想定される.

したがって CPA1 のバウンダリーは，染色機，ボイラー，工場の水処理システム，排水処理システムまた DEPZ の水供給及び電力供給システムを含むエリアと想定する（下記の図での点線に囲まれた範囲）.

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[22] Guide for Assessment of Effluent Treatment Plants, Department of Environment Ministry of Environment and Forest, Bangladesh, 2008.

[23] 40 の工場に調査を行った結果，38工場が反応染色手法を使っていた.

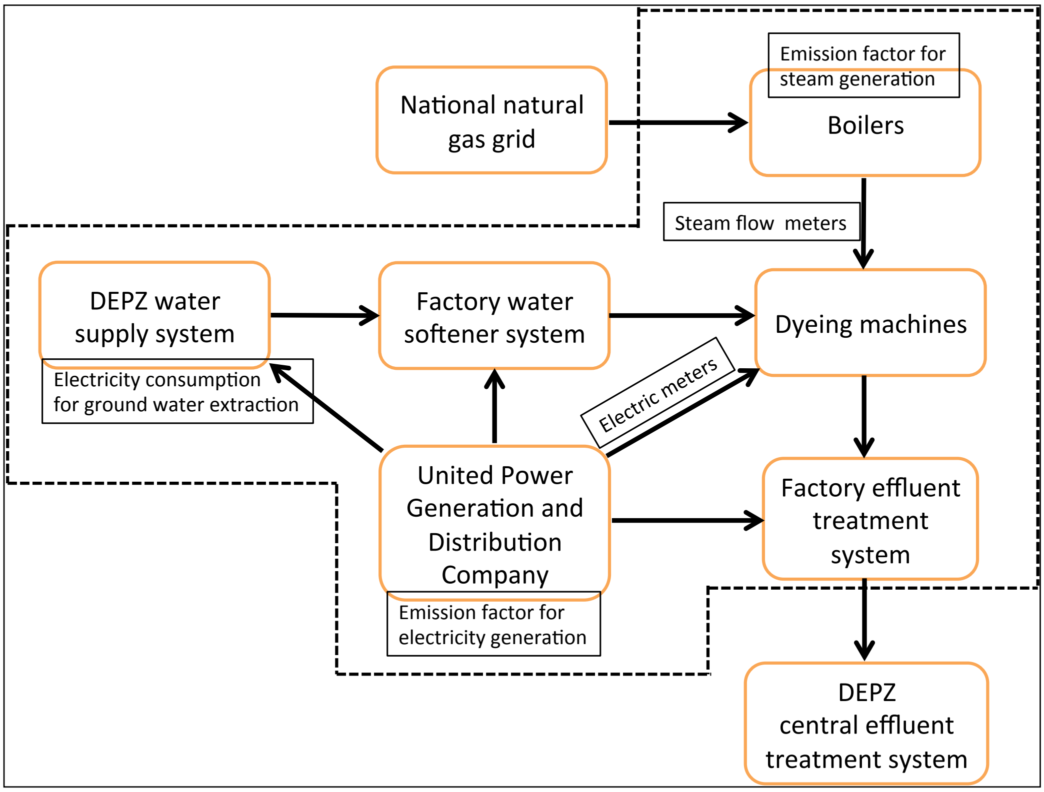

図-13　CPA1 のバウンダリー設定

当該 PoA において，対象/考慮すべき温室効果ガスの種類に関しては，以下の表に示したように二酸化炭素のみを考慮し，他の温室効果ガスは対象外とする．

表-14　対象温室効果ガスの同定

	排出源	排出ガス	考慮する？	説明と正当性
ベースラインシナリオ	染色機における電力消費量	CO_2	する	重要な排出源
		CH_4	しない	重要ではない排出源，保守的に考慮しない
		N_2O	しない	重要ではない排出源，保守的に考慮しない
	染色機における蒸気消費量	CO_2	する	重要な排出源
		CH_4	しない	重要ではない排出源，保守的に考慮しない
		N_2O	しない	重要ではない排出源，保守的に考慮しない
	染色用水ポンプで引	CO_2	する	重要な排出源

	き上がるための電力消費量	CH_4	しない	重要ではない排出源，保守的に考慮しない
		N_2O	しない	重要ではない排出源，保守的に考慮しない
プロジェクトシナリオ	染色機における電力消費量	CO_2	する	重要な排出源
		CH_4	しない	重要ではない排出源，簡易化のため考慮しない
		N_2O	しない	重要ではない排出源，簡易化のため考慮しない
	染色機における蒸気消費量	CO_2	する	重要な排出源
		CH_4	しない	重要ではない排出源，簡易化のため考慮しない
		N_2O	しない	重要ではない排出源，簡易化のため考慮しない
	染色用水ポンプで引き上がるための電力消費量力	CO_2	する	重要な排出源
		CH_4	しない	重要ではない排出源，簡易化のため考慮しない
		N_2O	しない	重要ではない排出源，簡易化のため考慮しない

3.1.6 ベースライン排出量

各 CPA によるベースライン排出量は，以下に示す数式によって計算できる．

$$BE_y = (EC_{Dyeing,y}^{BL} + EC_{Water,y}^{BL}) \times EF_{CO2}^{BL,elec} + SC_y^{BL} \times EF_{CO2}^{BL,steam} \tag{1}$$

ここで，

BE_y	Baseline emissions in a year *y* (CO_2 ton/year)
$EC_{Dyeing,y}^{BL}$	Baseline electricity consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year *y* (kWh/year)
$EC_{Water,y}^{BL}$	Baseline electricity consumption by pumping of fresh water that used in dyeing machines in year *y* (kWh/year)
SC_y^{BL}	Baseline steam consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year *y* (ton-steam/year)
$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EF_{CO2}^{BL,steam}$	CO_2 emission factor for the steam generation for the factory (ton CO_2/ton)

$$EC^{BL}_{Dyeing,y} = \sum_{i}\sum_{j}\sum_{k}\sum_{l} EC^{BL,Batch,dyeing}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \tag{2}$$

ここで，

$EC^{BL}_{Dyeing,y}$	Baseline electricity consumption by dyeing processes in year *y* (kWh/year)
$EC^{BL,Batch,dyeing}_{i,j,k,l}$	Historical average electricity consumption of a dyeing machine *i* for a batch in the baseline dyeing process for brightness of colour *j* material *k* at a load-type of *l* (kWh/batch)
$NB^{PJ}_{i,j,k,l,y}$	Number of batches on a dyeing machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year *y*
i	Types of dyeing machines in the factory (different maker and different capacity)
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EC^{BL}_{Water,y} = \sum_{i}\sum_{j}\sum_{k}\sum_{l} WC^{BL,Batch}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \times EC^{BL,pumping}_{clean,water} \tag{3}$$

ここで，

$EF^{BL}_{Water,y}$	Baseline electricity consumption by pumping of water that used in dyeing machines in year *y* (kWh/year)
$WC^{BL,Batch}_{i,j,k,l}$	Historical average water consumption in machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* (Litre/batch)
$B^{PJ}_{i,j,k,l,y}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
$EC^{BL,pumping}_{clean,water}$	Historical average electricity consumption for pumping groundwater (kWh/liter)
i	Type of dyeing machines in the factory
j	Color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Different load for dyeing a machine in the factory

$$SC^{BL}_{y} = \sum_{i}\sum_{j}\sum_{k}\sum_{l} SC^{BL,Batch}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \tag{4}$$

ここで、

SC_{y}^{BL}	Baseline steam consumption by dyeing processes in year *y* (ton/year)
$SC_{i,j,k,l}^{BL,Batch}$	Historical average steam consumption of a dyeing machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load-type of *l* (ton-steam/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load-type of *l* in a year *y*
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EF_{CO2}^{BL,elec} = \frac{FC_{gen}^{BL,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{BL,fuel}} \qquad (5)$$

ここで、

$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EG_{gen}^{BL,fuel}$	Historical average of electricity generated from generators (kWh/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{gen}^{BL.fuel}$	Historical fuel consumption average of generators (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)
$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{BL,steam} = \frac{FC_{boiler}^{BL,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{BL,fuel}} \qquad (6)$$

ここで、

$EF_{CO2}^{BL,steam}$	CO_2 emission factor for the steam generation (ton CO_2/ton steam)
$SP_{steam}^{BL,fuel}$	Historical amount of steam produced from boilers (ton-steam/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{steam}^{BL,fuel}$	Historical fuel consumption of boilers (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)
$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

3.2 プロジェクト排出量

3.2.1 プロジェクト排出量

プロジェクト活動からの排出量は，下記の式で計算を行う．

$$PE_y = (EC_{Dyeing,y}^{PJ} + EC_{Water,y}^{PJ}) \times EF_{CO2}^{PJ,elec} + SC_y^{PJ} \times EF_{CO2}^{PJ,steam} \qquad (7)$$

ここで，

PE_y	Project emission in a year y (CO$_2$ ton/year)
$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (kWh/year)
$EC_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in the factory in year y (kWh/year)
SC_y^{PJ}	Project steam consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (ton-steam /year)
$EF_{CO2}^{PJ,elec}$	CO$_2$ emission factor of electricity generation for the factory (ton CO$_2$/MWh)
EF_{CO2}^{steam}	CO$_2$ emission factor for the steam generation for the factory (ton CO$_2$/ton)

$$EC_{Dyeing,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{PJ,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} \qquad (8)$$

ここで，

$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing processes in year *y* (kWh/year)
$EC_{i,j,k,l}^{PJ,Batch,dyeing}$	Electricity consumption of a machine *i* for a batch in the project dyeing process for brightness of colour *j* material *k* at a load-type of *l* (kWh/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year y
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EF_{Water,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{fresh,water}^{PJ,pumping} \qquad (9)$$

ここで、

$EF_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in year y (kWh/year)
$WC_{i,j,k,l}^{PJ,Batch}$	Water consumption in machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* (Litre/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
$EC_{fresh,water}^{PJ,pumping}$	Average electricity consumption for pumping underground water in the project in year y (kWh/liter)
i	Type of dyeing machines in the factory
j	Color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Different load for dyeing a machine in the factory

$$SC_y^{PJ} = \sum_i \sum_j \sum_k \sum_l SC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} \qquad (10)$$

ここで、

SC_y^{BL}	Project steam consumption by dyeing processes in year *y* (ton-steam /year)
$SC_{i,j,k,l}^{BL,Batch}$	Steam consumption of a machine *i* for a batch in the baseline dyeing process for brightness of colour *j,* material *k* at a load-type of *l* (ton-steam /batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year *y*
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing a machine in the factory

$$EF_{CO2}^{PJ,elec} = \frac{FC_{gen}^{PJ,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{PJ,fuel}} \qquad (11)$$

ここで、

$EF_{CO2}^{PJ,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EG_{gen}^{PJ,fuel}$	Amount of electricity generated from generators (kWh/year) in year y.
$FC_{gen}^{PJ.fuel}$	Amount fuel consumption of generators (m^3/year) in a year y.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)

$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{PJ,steam} = \frac{FC_{boiler}^{PJ,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{PJ,fuel}} \qquad (12)$$

ここで，

$EF_{CO2}^{PJ,steam}$	CO_2 emission factor for the steam generation for the factory (ton CO_2/ton steam)
$SP_{steam}^{PJ,fuel}$	Amount of steam produced from boilers (ton-steam/year) in a year y.
$FC_{steam}^{PJ,fuel}$	Amount of fuel consumption of boilers (m^3/year) in a year y.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)
$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

3.2.2 リーケージ

当該 PoA での CPA におけるリーケージは，ゼロと想定できる．
したがって，

$$L = 0 \qquad (13)$$

3.3 モニタリング計画

当該 PoA の調整管理組織である W.S.T を中心に，全体のモニタリングが実施される．

モニタリングにおける各実施機関の役割とモニタリング項目は以下の通りである．
モニタリング項目（モニタリング頻度）：

- プロジェクトにおける年ごとのバッチの数（月ごとに集計）
- 染色機におけるバッチあたりの水消費量（バッチごと）
- 染色機における電力消費量（バッチごと）
- 染色機における蒸気消費量（バッチごと）
- 工場に給電する発電所における年間発電量および燃料消費量（年一度）

ここで「バッチごと」というのは，前述のように，染色機ごとに，9 種類の染色用途ごとに前もって，「ベースラインは過去実績としてキャンペーン測定を行った値をデフォルト値とし」，「プロジェクトは実測する」ということを，バッチごとに行うことを意味している．プロジェクトの実測は，前述のよう W.S.T のスタッフがサンプリングとして測定することをする．具体的に，染色機に測定機器（外付けの機器あるいは内部の機器が機能して

ない）がない場合，染色機ごとに測定器を設置し，実測を行う．外付けの測定器は，電力計，蒸気及び水流量計のことである．染色機にすでに内部モニタリング機器があってかつ順調に機能している場合，その記録データを用いる．

モニタリングは90/10の信頼度を保証する．工場への注文によって事前に各材料・色の組み合わせごとに染色レシピが用意される．そのレシピのバッチの中から，サンプルのバッチのみを測定する．

表-15 各機関のモニタリングにおける役割

項目	W.S.T（CME） PEARがサポートする	各工場 （プロジェクト実施者）	注釈
モニタリング管理	モニタリング計画・手法の開発 モニタリングの管理	モニタリングを実施・管理	
データ収集	データ収集システムの開発 データのチェック	データの収集 データおのチェック	
データ保存と管理	データベースの作成 データのチェック 排出削減量の計算 データの保存・管理	電子データベースの作成 データの保存・管理	
報告	データのチェックと分析 月報及び年報の作成	CMEへのデータ提供	
CDM能力向上	能力向上プログラム策定と実施の監視	工場内部能力向上の実施	
QA/QC	QA/QCシステムの確立，順調な検証を保障	検証においてCMEを支援する	

適用技術及び事業実施・運営の体制を踏まえて，モニタリング計画またマニュアルが定められる．

3.4 温室効果ガス削減量

本PoAの最初のCPAによって削減できる温室効果ガスの量の事前推定結果を下記の表にまとめる．

前述の計算式を用いて，下記の想定の下，排出量削減量の試算を行う．

- 平均バッチ数は，4,000

- 全部コットンと想定
- 各染色機は 95% の load capacity で働く
- バッチのうち 80%の濃色, 10%のミディアム色，10%の明るい色

ベースライン排出量:

$$BE_y = (EC_{Dyeing,y}^{BL} + EC_{Water,y}^{BL}) \times EF_{CO2}^{BL,elec} + SC_y^{BL} \times EF_{CO2}^{BL,steam} \quad (1)$$

= (713,920+58,576)* 0.483/1000+ 19,374*0.139 = 3,066 ton CO_2/year

$$EC_{Dyeing,y}^{BL} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{BL,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} \quad (2)$$

W.S.T の調査により，GK の 5 台の染色機のバッチあたりの電力消費量は，下記の通りである．

Machine: ATHENA (with 1000 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	247	252	265
CVC	336	350	365
Polyester	191	194	196

Machine: HT-4 (with 720 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	182	186	195
CVC	248	258	269
Polyester	141	143	145

Machine: AT-4 (with 720 kg capacity)

Unit: kWh/batch

Load capacity: 95%　　（本染色機は，普段コットンだけの使われる）

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	182	186	195
CVC			
Polyester			

Machine: HT-3 (with 540 kg capacity)

Unit: kWh/batch

Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	143	146	154
CVC	195	203	212
Polyester	111	113	114

Machine: HT-1 (with 180 kg capacity)

Unit: kWh/batch

Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	87	89	94
CVC	119	124	129
Polyester	68	69	69

したがって，

$$EC_{Dyeing,y}^{BL} = [(265*640+252*80+247*80)+(195*640+186*80+182*80)+ (195*640+186*80+182*80)+ (154*640+146*80+143*80)+ (94*640+89*80+87*80)] = 713,920 \text{ kWh/year}$$

$$EC_{Water,y}^{BL} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{clean,water}^{BL,pumping} \qquad (3)$$

W.S.T の調査により，GK の各染色機のバッチあたりの水消費量は，下記の通りである．また，DEPZ の水供給場で使用されているポンプの性質また地下水位等[24]のデータから下水を引き出すための電力消費量は，0.2 kWh/m^3 と算定した．

Machine: ATHENA (with 1000 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	86,800	96,500	107,300
CVC	107,300	110,900	121,700
Polyester	64,100	67,700	71,300

Machine: HT-4 (with 720 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	73,972	79,972	88,792
CVC	88,972	91,972	100,972
Polyester	52,972	55,972	58,972

Machine: AT-4 (with 720 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	73,972	79,972	88,792
CVC			
Polyester			

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[24] DEPZ に水供給場で用いられているポンプは，水中混成流型ポンプで，出力は，90~180 m^3/hr, モーター定格は，85HP である．DEPZ では，水頭は，80~100 m である．ポンプの電力は，63 kW であるが，上記の状況で，100%の効率（保守的な考え）で働いたとしたら，電力＝flow rate (m3/s)*密度（1000 kg/m3）*重力係数（9.81m/s2）*，水頭（m）／ポンプの効率（%）＝39 kW.

Machine: HT-3 (with 540 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	56,104	60,604	67,354
CVC	67,354	69,604	76,354
Polyester	43,354	42,604	44,854

Machine: HT-1 (with 180 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	20,368	21,868	24,118
CVC	24,118	24,868	27,118
Polyester	15,118	15,858	16,618

したがって，

$EF_{Water,y}^{BL}$= [(107.3*640+96.5*80+86.8*80)+(88.792*640+79.972*80+73.972*80)+
(88.792*640+79.972*80+73.972*80)+
(67.354*640+60.604*80+56.104*80)+
(24.118*640+21.868*80+20.368*80)]*0.2
= 58,576 kWh/year

$$SC_{y}^{BL} = \sum_{i}\sum_{j}\sum_{k}\sum_{l} SC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \quad (4)$$

W.S.T の調査により，GK の各染色機のバッチあたりの蒸気消費量は，下記の通りである．

Machine: ATHENA (with 1000 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	5,698	6,139	6,719

CVC	7,588	78,09	8,389
Polyester	5,238	5,458	5,679

Machine: HT-4 (with 720 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	4,622	4,990	5,474
CVC	6,082	6,265	6,750
Polyester	2,280	1,989	2,964

Machine: AT-4 (with 720 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	4,487	4,854	5,329
CVC			
Polyester			

Machine: HT-3 (with 540 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	3,414	3,689	4,049
CVC	4,473	4,611	4,970
Polyester	3,254	3,208	3,346

Machine: HT-1 (with 180 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	1,167	1,259	1,382
CVC	1,504	1,586	1,708
Polyester	1,057	1,103	1,149

したがって,

SC_y^{BL}= [(6,719*640+6,139*80+5,698*80+(5,474*640+4,990*80+4,622*80)+
(5,329*640+4,854*80+4,487*80)+
(4,049*640+3,689*80+3,414*80)+ (1,382*640+1,259*80+1,167*80)]/1,000
=19,374 ton-steam/year

$$EF_{CO2}^{BL,elec} = \frac{FC_{gen}^{BL,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{BL,fuel}} \qquad (5)$$

GK の工場に電力を提供している United Power generation and Distribution の発電効率は, 0.24 m^3/kWh であり, これをベースに試算結果は, 下記のようになる.

$EF_{CO2}^{BL,elec}$= 0.448 ton CO_2/MWh

$$EF_{CO2}^{BL,steam} = \frac{FC_{boiler}^{BL,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{BL,fuel}} \qquad (6)$$

工場で蒸気提供のために用いられているボイラーは, 2 台とも Cochran の borderer (10.34 Bar G)ガスボイラーであり, メーカーからのカタログ[25]での定格効率からこの係数を計算することは保守的なある. したがって,

$EF_{CO2}^{BL,steam}$= 0.139 ton CO_2/ton-steam

プロジェクト排出量:

W.S.T の調査によると, 当該 PoA で導入される技術によって, GK の工場において, 染色過程用電力消費量を 75%, 蒸気消費量を 50%削減できると言われている. そこで, この仮定をベースに排出削減量の試算を行う.

$$PE_y = (EC_{Dyeing,y}^{PJ} + EC_{Water,y}^{PJ}) \times EF_{CO2}^{PJ,elec} + SC_y^{PJ} \times EF_{CO2}^{PJ,steam} \qquad (7)$$

PE_y = (713,920+58,576)* 0.483/1000*0.25+ 19,374*0.139*0.5 = 1,439 ton CO_2/year

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[25] www.cochran.co.uk

排出削減量：

$$ER_y = BE_y - PE_y - L_y \qquad (8)$$

= 30,66 – 1,439 – 0 = 1,627 ton CO_2/year.

表-16 温室効果ガス削減量事前推定結果

年 (開始日)	プロジェクト 排出量 (tonnes of CO_2 e)	ベースライン 排出量 (tonnes of CO_2 e)	リーケージ (tonnes of CO_2 e)	排出削減量 (tonnes of CO_2 e)
1/6/2013	1,439	30,66	0	1,627
1/6/2014	1,439	30,66	0	1,627
1/6/2015	1,439	30,66	0	1,627
1/6/2016	1,439	30,66	0	1,627
1/6/2017	1,439	30,66	0	1,627
1/6/2018	1,439	30,66	0	1,627
1/6/2019	1,439	30,66	0	1,627
1/6/2020	1,439	30,66	0	1,627
1/6/2021	1,439	30,66	0	1,627
1/6/2022	1,439	30,66	0	1,627
Total	14,390	30,660	0	16,270

3.5 プロジェクト期間・クレジット獲得期間

各 CPA のプロジェクト期間は，20 年とする．これは染色機の耐用年数にもとづき保守的に設定した．一方，PoA のクレジット期間は 28 年で，各 CPA のクレジット期間はそれぞれ 10 年と設定する．

3.6 環境影響・その他の間接影響

当該PoAの実施により，環境への負の影響はないと思われる．さらに，当該PoAで推進する技術は，染色手法の変化を図るもので，工場での既存の機械・設備などの変化を必要しない．各工場は，グラデシュ政府の環境保全規定(The Environment Conservation Rules, 1997)にしたがって，環境省（または地方レベルでの対応機関）より環境認可証明書(ECC)を取得しており，当該PoAのために環境認可証明書を取得する必要はない．

本PoA実施によって生じる便益は下記のとおりである．

バングラデシュの水安全保障に貢献する:

バングラデシュには，飲み水のために，地下水が主に使われており，近年，繊維加工工場の数の増加に伴う地下水の大量の利用により，ダッカ周辺で，地下水位の低下が著しくなっている．当該 PoA は，節水・省エネ技術の推進によって，繊維加工工場における水の消費量を削減でき，水安全保障において，意義を持つ．

バングラデシュにおける地盤沈下の緩和に貢献する:

ダッカ周辺地域において，地下水位の低下によって地盤沈下が発生している．当該 PoA が，繊維加工工場における水の消費量を削減でき，地盤地下の緩和に貢献できるといえる．

健康面の便益:

PoA によって導入される技術は，染色におけるエンザイム(酵素)処理をなくすことで，労働者の労働環境の改善ができる．エンザイム処理された繊維を扱う場合，長期的に労働者の呼吸器官などに悪影響が生じる．

3.7 利害関係者のコメント

2012 年 11 月 5 日に PoA レベルでの利害関係者のコメントのコンサルテーションが，ダッカにおいて行われ，利害関係者に対して，意見/コメントの収集を行った．

参加者は，各工場，専門家，NGO 及び政府関係者を含む 50 名であった．

したがって，本 PoA に対して，否定的な意見とコメントなく，事業に対しての期待感が表れた．参加者からの意見/コメントは，下記となった：

表-17 利害関係者の意見・コメント

Stakeholder comment	**Was comment taken into account (Yes/ No)?**	**Explanation (Why? How?)**
Is this project can reduce the use of chemical & if yes how? (Mr. Mohammad Roqibul Islam from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH)	Clarification was given	This project can reduce the use of chemical for textile wet processing. Because in textile wet processing the chemicals are dozing in g/liter, so according to our proposed technology (in which 30-40 liters of water are used for each kg cotton fabric processing) we are using less

		amount of water then the existing system (100 liters of water for each kg fabric processing) that's how we are saving chemicals.
Does the concentration of chemical increase in ETP (Effluent Treatment Plant) after the implementation of the project? If increase then how you will control this? (Mr. Mohammad Roqibul Islam from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH)	Clarification was given	No our project does not increase the concentration of chemical in the ETP. So we don't need to control this matter in ETP.
Why you are working only on two-model factories? (Mr. Zaman from Jamuna Group)	Clarification was given	At present, we are actively working with the two factories (Grameen Knitwear Ltd. & Landmark Fabrics Limited) to register the programmatic CDM (PoA) as a CDM project. After registration the entire interested factory can be included to the programme.
How other factories can be a part of this Project and what are the criteria for this? (Mr. Zaman from Jamuna Group)	Clarification was given	Other factories also can be a part of this project as a CPA (Component Project Activity) after the PoA registered to be CDM project. Any textile and garment factory in Bangladesh can apply participation of the PoA through implementing water and energy technologies proposed by W.S.T. So please contact with W.S.T which will advise you on what kind of

		technologies will appropriate for your factory.
Does your technology can overcome the fastness problem of red and dark black? (Mr. Zaman from Jamuna Group)	Clarification was given	Our proposed technology can overcome this problem. By choosing the appropriate process of dyeing from our proposed options this problem can easily solved.
If we invite you, are you interested to come to our factory? (Mr. Zaman from Jamuna Group)	Yes	We are interested to work with factories who are believing and willing to apply our idea
May we take back the sustainable development matrix and return it by e-mail with full completion? (Mr. Sohag Miah from NIAGARA TEXTILES LTD)	Yes	You can complete the table after the meeting and send it back us with e-mail. And kind of continues inputs are welcome by e-mail and telephone.

図-14　利害関係者会議のようす

3.8 プロジェクトの実施体制

本 PoA の実施体制を下記の図にまとめる：

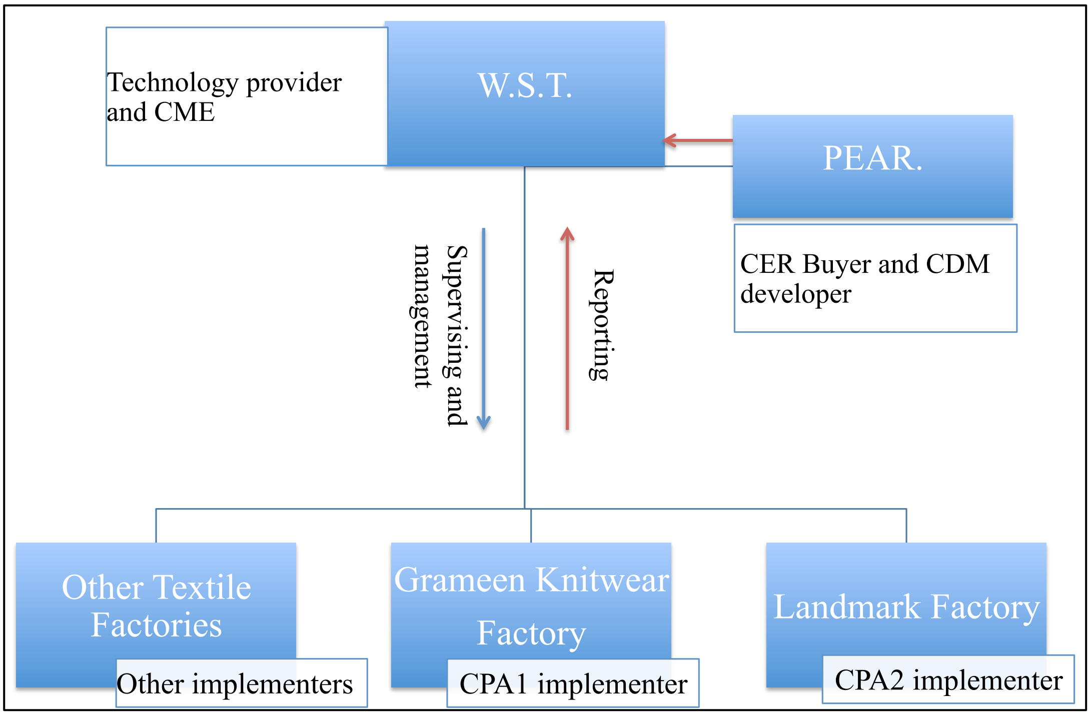

図-15　PoA の実施体制

W.S.T は，当該 PoA の調整管理組織として，各参加者の間で調整を行い，各 CPA 関連のデータと情報の収集と管理を担当する．また，DOE 及び CDM 理事会とのコミュニケーションを行う．PEAR は，PoA の参加者として，W.S.T の仕事をサポートする．

各 CPA の事業実施・運営は，各工場があたる．

各事業実施者は，W.S.T に対して，調査およびモニタリング結果を報告する義務があり，W.S.T は，各実施者から提供されてきたデータ及び情報に対して，チェックを行い，確認済みのデータ及び情報に基づいて，排出削減量に計算を行ったり，データのファイリングと管理を行ったりする．

各工場は自主的に事業に参加することになる．また，データおよび情報の収集のために行われる調査などに協力することに同意する．

3.9 資金計画

当該 PoA における技術は，染色機での染色処理手法の最適化であり，既存設備をそのまま使うことができる．プロジェクト自身には，初期投資はほとんど不要であり，投資は，CDM 化のための投資のみである．

3.10 経済性分析

3.10.1 分析の前提条件

経済分析のために，染色過程において最も染色材と染色時間が必要となる黒のコットンの 1 バッチを例に GK の工場における採算性分析を示す．

工場にとって，便益は，バッチ時間短縮にとるエネルギー，水，薬剤などの節約，コストは，導入技術に必要となる薬剤と材料（low twist cotton yarn）における追加的な資金と CDM のコスト（モニタリングのための測定機器を含む）．

経済性分析に用いられた基礎情報を下記の表で示す[26]．ここで，提示された情報は，GK の工場におけるコットン 40kg を黒色に染めた場合，既存の反応染色と提案する直接染色のために必要となる要素（染色剤，薬剤，水，エネルギー及び労働）の消費量とコストの比較である．さらに，マイナスの数値は，追加的なコスト，プラスの数値は，節約のコストを示す．表-19 で示したように染色方法を，反応染色から直接染色を転換することで，10. 34 US$/40kg のコスト節約（便益）になる[27]．

3.10.2 分析結果

ここで，下記のような想定の下で，CDM のためのコストなども含みながら経済分析を行う．また，当該プロジェクトには，初期コストが，必要はないため，経済指標として，IRR ではなく，純便益で表することにする．CER の価格は，9 EUR/t CO_2e と想定．

- 平均バッチ数は，4,000
- 全部コットンと想定
- 各染色機は 95% の load capacity で働く
- バッチのうち 80%の black color, 10%の medium color, 10%の light color

また，モニタルングのために，電力測定器（各染色機一つずつ），蒸気量測定（一つ）及び水量測定器（一つ）を購入する．この場合，以下のように便益が評価できる：

表ー18 プロジェクトの便益評価

シナリオ	純便益 (Thousand US$)
CER 収益なし	7,450
CER 収益あり	7,477

1 EUR = 1.31868 USD

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[26] W.S.T の調査より

[27] この数値は，染色機，材料また時間（染色剤，薬剤，材料などの市場価格）によって異なる．

表-19 コスト比較

染色剤・補助剤	反応染色				直接染色				コスト変化
	染色・補助剤の消費量/40kg（コットン）		値段（USD/Kg）	総計（USD/40 kg）	染色・補助剤の消費量 /40kg（コットン）		値段（USD/Kg）	総計（USD/40kg）	(USD/40 kg)
Detergent		0.16	2.1	0.34		0.32	2.1	0.67	-0.34
Anticrease		0.48	1.05	0.50		0.32	1.05	0.34	0.17
Soda Ash		6.4	0.27	1.73		0.64	0.22	0.14	1.59
AntiFoaming Agent		0.02	4.9	0.10		0.05	5	2.5	-2.40
Acid		0.76	1.1	0.84		0.38	1.1	0.25	0.59
Peroxide Stabilizer		0.13	1.1	0.14		0.06	1.1	0.07	0.08
Dyes	Cibacron Supra Black G	1.44	6	8.64	Solophenyl Black FR	1.6	7.75	12.4	-3.76
	Cibacron Red S-2B	0.76	8	6.08		0	1	0	6.08
	Cibacron Yellow S3R	0.48	6.7	3.22		0	1	0	3.22
G.Salt		32	0.14	4.48		8	0.14	1.12	3.36
Peroxide		0.96	0.5	0.48		0.5	0.5	0.25	0.23
Caustic Soda		0.8	0.81	0.65		0.16	0.41	0.07	0.58
Fixing		0.32	4	1.28		0.96	4	3.84	-2.56
Softener		0.1	2	0.2		0.1	2	0.2	0.00
Sequestering Agent		0.13	1.2	0.156		0	0	0	0.16
PeroxideKiller		0.1	2.3	0.23		0	0	0	0.23
Levelling		0.32	2.1	0.67		0	0	0	0.67
Wash Off		0.32	1.25	0.4		0	0	0	0.40
Enzyme		0.4	4.8	1.92		0	0	0	1.92
小計									**10.21**
その他の項目におけるコスト削減と増加									
Water consuption in liter		4,320	0.00035	1.51		2,400	0.00035	0.84	0.67
Power consuption in kWh		25.6	0.08	1.92		12.8	0.08	0.96	0.96
Steam consumption									3.50
Yarn cost									-17.00
Labor cost									12.00
小計									**0.13**
総計									**10.34**

表-20 キャッシュフロー(CER なし)

Unit: Thousand USD

Items		0	1	2	3	4	5	6	7	8	9	10
Cash inflow		0	**2626.0**	**2626**	**2626**	**2626**	**2626**	**2626**	**2626**	**2626**	**2626**	**2626**
Reduction cost for dyestuff and other chemicals		0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0
Water saving		0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Steam saving		0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Power saving		0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0
Labor cost saving		0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0
Cash outflow		0	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**	**1881.0**
Additonal cost for dyestuff and other chemicals		0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0
Additional cost for high quality yarn		0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0
Net Cashflow		0	745.0	745.0	745.0	745.0	745.0	745.0	745.0	745.0	745.0	745.0
Net benefit	7450.00											

表-21 キャッシュフロー(CER あり)

Unit: Thousand USD

Items		0	1	2	3	4	5	6	7	8	9	10
Cash inflow		0	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**	**2645.0**
Reduction cost from dyestuff and other chemicals		0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0	1391.0
Water saving		0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Steam saving		0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0	252.0
Power saving		0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0
Labor cost saving		0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0	866.0
CER income		0	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
Cash outflow		(12.3)	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**	**1896.0**
Additonal cost for dyestuff and other chemicals		0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0	654.0
Additional cost for high quality yarn		0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0	1227.0
Cost for power meters		(1.00)	0	0	0	0	0	0	0	0	0	0
Csot for steam flow meters		(10.00)	0	0	0	0	0	0	0	0	0	0
Cost for water flow meter		(1.30)										
Verification cost		0	15	15	15	15	15	15	15	15	15	15
Net Cashflow		(12.3)	**749**	**749**	**749**	**749**	**749**	**749**	**749**	**749**	**749**	**749**
Net benefit	7477.70											

3.10.3 感度分析

当該プロジェクトにおいて，特に経済的なリスクは，存在しないが，CER の変化によるプロジェクト便益の変化を見てみるために感度分析を行った．この分析以下の表にまとめた．なお，CER 価格は実際は W.S.T の CDM 推進要因にはなっていない（高品質の環境認証としての価値を重視）．また，現状の ton あたり 1 ユーロを切る価格で評価してもほとんど差異はない（この評価の意味がない）ため，将来価格が上昇すると仮定している（現時点ではその可能性もかなり薄いが）．

表-22 感度分析

	CERの販売価格（EUR/t CO_2 e)		
	5	7	9
便益（USD)	7,397	7,437	7,793

3.11 追加性の証明

追加性に関しては，各 CPA の追加性を適格性要件という形で PoA-DD に記述することとなる．PoA の追加性に関しては，個々の CPA が追加的であれば PoA も追加的であるという判断が CDM 理事会によってなされているので問題はない．

CPA の追加性について，適格性条件として基本的に以下の手法で証明する．

(1) CPA が micro scale の場合：

”GUIDELINES FOR DEMONSTRATING ADDITIONALITY OF MICROSCALE PROJECT ACTIVITIES, version 04”のパラグラフ 3 によって，論証を行う．

3. Energy efficiency project activities[28] *that aim to achieve energy savings at a scale of no more than 20 gigawatt hours per year are additional if any one of the conditions below is satisfied:*
(a) The geographic location of the project activity is in an LDC/SIDS or special underdeveloped zone of the host country identified by the government in accordance with the paragraph 2 (a) (i) above;
(b) The project activity is an energy efficiency activity with both conditions (i) and (ii) below satisfied:
(i) Each of the independent subsystems/measures in the project activity achieves an estimated annual energy savings equal to or smaller than 600 megawatt hours;
(ii) End users of the subsystems or measures are households/communities/SMEs.

バングラデシュは，LDC であり，CPA により年間省エネルギーの総計は，20 GWh あるいは 60 GWh_{th} を超えなければ，その CPA の追加性はあることになる.

例えば，CPA1 の場合， 電力の削減からの年間省エネ量は，0.58 GWh/year，一方，蒸気削減からの省エネ量は，9,687 ton steam/year である. 蒸気のエンタルピーは，659.59 Kcal/kg また 1 Kcal = 0.001163 kWh であることから，CPA1 の年間総計省エネ量は，0.58*3+ 9687000*659.59*0.001163 = 7.4 GWh_{th} となる.

したがって，CPA1 の追加性は問題ない.

(2) CPA が，上記の micro scale の条件を満たさなかった場合：
"Guidelines on the demonstration of additionality of small-scale project activities, version 09"によって，Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissionsの論証を経て，追加性の証明をすることも可能である.

論証の方法としては，適切な統計資料もしくは文献（定量化されているもの），専門家判断，それをサポートする文献（現在のコモンプラクティスである反応性染料が用いられるようになった経緯や理由など）を示すこととする予定である（それらのミックス）. 統計資料は現時点では唯一無二とできるものはないため，場合によっては質問票形式のサーベイを行った.

Department of Environment の調査によるとバングラデシュでの織維加工分野で 95%のコットンの染色は，反応染色手段で行われている29. また，質問状形式サーベイ（電

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[28] All technologies/measures included in approved Type II small-scale CDM methodologies are eligible to be considered. Further, the Board at its fifty-seventh meeting clarified that all CDM project activities that meet the criteria specified in the guidelines are eligible to apply the guidelines irrespective of the scale of the approved CDM methodology applied to the project

[29] Guide for Assessment of Effluent Treatment Plants, Department of Environment
Ministry of Environment and Forest, Bangladesh

話サーベイも含む）によると，現時点の結果をよると40の工場のうち，38工場が反応染色を行っているという結果だった．したがって，当該PoAで提案する技術は，投資も必要しないかつコスト削減につながるものにもかかわらず，織維加工工場において，現実として使われていない．排出量の多い反応染色手法が，prevailing practiceであると言える．

しかし，CPA1のGKの工場は，規模として，バングラデシュでは，中レベルの工場で，本工場からの省エネの試算から，バングラデシュでの殆どの工場に対して，micro scaleの基準で追加性の証明の可能性が高いと思われるが，もし，CPAが，micro scaleの要件を満たしてなかった場合に関しては，下記の規定を用いる：

Guidelines for demonstrating additionality of micro scale project activities (Version 04.0), Para 8 (a):[30]

8. The eligibility of project activities as micro scale CDM project activities will be determined in accordance with the principles laid out in paragraph 3 and paragraph 4 of the “General Guidelines to SSC CDM methodologies” (version 16 or its update), i.e.:

(a) Project activities remain under the thresholds defined above during each year of the crediting period and in cases where ex ante projected emissions reductions show an increase during the crediting period; project activities that go beyond the micro scale limits in any year of the crediting period are not eligible;

これを用いて，マイクロスケールの閾値までしか CER をクレームしないとして，追加性論証を省略することにする．

3.12 事業化の見込み

前述のよう当該 PoA を実施にあたって，初期投資は，ほとんど必要としない．CDM化に必要となる資金は，基本的に，各CPAの実施工場が提供者であり，CDM事業に積極的なことから，資金的要因が事業化の障害になることは考えにくい．また，本プロジェクトで使用予定の技術も，バングラデシュ国内で使われていないが，染色の分野では，新しいものではなく（むしろ早期に使用された）成熟した技術である（それを現代のニーズに新規にアレンジしたものといえる）．W.S.Tの指導・推進で，CPA1の実施によって，横展開においても，技術的要因が事業展開のうえで障害になる可能性は低いと思われる．

総合的に考えると，気別対応が必要なため普及には時間を要するものの，現時点では事業化の見込みは問題ないと考えられる．

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[30] http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid22.pdf

4 有効化審査

4.1 有効化審査の概要

2012 年 12 月 1 日から本案件の CDM 化においての有効審査が始まっており，PoA-DD，CPA-DD(specific)が UNFCCC の Web においてパブリックコメントに公示されている：
http://cdm.unfccc.int/ProgrammeOfActivities/Validation/DB/05BQ1QTQAWFAXGB047CE9TIQVA3707/view.html
有効審査の現地調査（side visit）は，2013 年 5 月 5 日から 1 月 10 日までに行われた．

4.2 DOE とのやりとりの経過

2012 年 12 月中旬に，DOE に PoA-DD，CPA-DD(specific)を提出し，DOE とのやりとりを経て，2012 年 12 月 1 日に UNFCCC のホームページで公示された（とくにコメントはなかった）．
現地調査の議論と結果を最終報告と PoA-DD に反映する（この報告書添付の PoA DD 等は，なお W.S.T の追加調査が完遂できていないため，上記グローバルステークホルダーコンサルテーションで公開されたバージョンである）．今後，詳細点を詰める必要がある．

5. コベネフィットに関する調査結果

5.1 背景

環境汚染という点では，既存の染色技術においてエンザイム処理された繊維が浸食され，粉塵（fiber dust）が発生し，屋内に浮遊することになる．このような繊維を扱う場合，長期的に労働者の呼吸器官などに悪影響が生じる．
導入の技術によりエンザイム（酵素）処理をなくすことで，労働者の労働環境の改善ができる．

5.2 環境省のマニュアルに基づく考察

環境省の「コベネフィット定量評価マニュアル第1.0版」は，環境分野のなかでもとくに水質，大気質，廃棄物の3つの分野を対象としていて，その他は今後の課題としている．ここでは，このプロジェクトで改善効果が見込まれる「大気質（とくに屋内）」に関して，考察を行う．

「大気汚染問題の改善」は，当該プロジェクトは，ベースラインであるエンザイム処理による工場内大気汚染の問題の改善が挙げられる．プロジェクトは，エンザイム処理を減らすため，屋内大気汚染の問題を解消できる．

なお，GHG削減効果は，ここではコベネフィッツとしては扱わない（CDMのコア部分でMRV評価するため）．

マニュアルのTierの分類では，実際の計測を行わずに文献調査をベースとするため，Tier 1による手法を採択する．マニュアルの用語での評価基準は「確実に排出削減効果が見込まれる」で，削減の確実性を表す評価点は5であると想定される．

一方で，「排出削減量見込み」は「評価軸（指標）と評価基準」に関して，「大気汚染物質の排出削減効果が確実に見込める」ということで，排出削減量見込みは，大とはいえる．しかし，評価指標において，マニュアルでは，「工場などのプラントから排出される排気ガス」や「自動車等からの排気ガス」が想定されているため，評価指標として，SOx，NOx，煤塵の「排出量」の削減効果を評価することを想定しているが，当該プロジェクトの場合，工場内の大気汚染が問題であり，各種スタディーにおいても，排出量情報の入手は難しい．当該プロジェクトのベースラインシナリオで発生するfiber dustは，bio-polishの原因になるエンザイム処理（wash）を使用しないことで，その活動分から完全に発生しなく，エンザイム処理を使用するバッチ数の減少率（割合）を指標として評価できる．

なお，上記は個々の工場における考察であるが，当然，プログラムCDMでは導入する規模に比例した効果（工場数の拡大）が見込まれる．この量のモニタリングは，CDMのモニタリングの中で扱うことができる．

また，当該プロジェクトの節水効果は，飲料水が足りないバングラデシュにおいて，大変意義を持つ効果であるが，本マニュアルには，水質だけを取り上げ，水量に関して，カバーしてないため，残念ながら，節水効果において，評価は行わない．

5.3 環境省のマニュアルの課題

上記のように，このプロジェクトのコベネフィッツを，環境省のガイドラインは，的確に表現しているとは言えない（単に排出量レベルの評価に過ぎない）．排出量から踏み込んだ評価手法のオプションを増やしていくべきであろう．

また，評価対象が狭いという面でも課題が残る．環境問題だけがコベネフィッツという誤解を与えかねないため，より枠を拡げるか，「環境面での」という但し書きを付けた方が望ましい（下記の Gold Standard の手法なども参考になる）．

6 持続可能な開発への貢献に関する調査結果

6.1 オーバービュー

当該PoAは，同時にGold Standard CDM プロジェクトとしても進行中である．持続可能な発展への貢献の問題は，Gold Standard の核心内容であり，当該 PoA においても，利害関係者のコンサルテーションも含む調査を通して作成された Sustainable Development Matrix は，下記となる．

表-23 持続可能な発展評価表

Indicator	**Mitigation measure**	**Relevance to achieving MDG**	**Chosen parameter and explanation**	**Preliminary score**
Gold Standard indicators of sustainable development	If relevant, copy mitigation measure from 'Do No Harm' assessment, and include mitigation measure used to neutralise a score of '-'	Check www.undp.org/mdg and www.mdgmonitor.org Describe how your indicator is related to local MDG goals	Defined by Coordinating and Managing Entity	Negative impact: score '-' in case negative impact is not fully mitigated, score '0' in case impact is planned to be fully mitigated No change in impact: score '0' Positive impact: score '+'
Air quality			Parameter: Amount of enzyme reduced in dyes. In textile and	+

			garment factories, particulate matters (PM) (enzyme dust and other micro dust) happen during the finishing process of garments. The programme will reduce enzyme wash and for dyeing process so that reduce air contamination with enzyme dusts.	
Water quality and quantity		MDG No.7 - Ensure environmental sustainability.	Parameter: Reduced amount of underwater water. The project will reduce consumption of underground water for textile dyeing process so that contribute to water security in Bangladesh	+
Soil condition			No significant change due to the programme	0
Other pollutants			No significant change due to the programme	0
Biodiversity			No significant	0

			change due to the programme	
Quality of employment			Parameter: Amount of enzyme reduced in dyes. Under the business as usual dyeing process, workers are exposed to Enzyme wash/treatment that may damage their respiratory organs over the long run. The project will not use enzyme in dyeing process so that avoid health risks of workers.	+
Livelihood of the poor			No significant change due to the programme	0
Access to affordable and clean energy services			No significant change due to the programme	0
Human and institutional capacity			No significant change due to the programme	0
Quantitative employment and income			No significant change due to the programme	0

generation				
Balance of payments and investment			CER revenue from the program	+
Technology transfer and technological self-reliance			Parameter: Number of visits to factories to teach technology and know-hows. The WST provides energy and water saving dyeing technology and know-how to textile factories through visiting the factories and auditing their energy and water consumptions for dyeing processes.	+

Justification choices, data source and provision of references (A justification paragraph and reference source is required for each indicator, regardless of score)	
Air quality	Bio-polishing or enzyme washing renders hazardous work environment, micro-dust in the work-floor (In process workshop and garments section). The micro-dust goes through eyes, and inhalations. “Bio-polishing- the disadvantages”, Syed Mohammad Ismail.
Water quality and quantity	One major problem for the sector is that factories generally draw water from scarce underground resources, using electric pumps. And given all seven industrial clusters of Bangladeshi garment-manufacturing units are located in and around the capital city of Dhaka, the problem of water scarcity has become acute. “Bangladesh’s T&C industry moving towards a sustainable future”, Raghavendra Verma.

	http://ei.wtin.com/article/LDGZL1668u2/2012/10/12/regional_profile_bangladeshs_tc_industry_moving_towards_a_su/
Soil condition	N/A
Other pollutants	N/A
Biodiversity	N/A
Quality of employment	Bio-polishing or enzyme washing renders hazardous work environment, micro-dust in the work-floor (In process workshop and garments section). The micro-dust goes through eyes, and inhalations. “Bio-polishing- the disadvantages”, Syed Mohammad Ismail.
Livelihood of the poor	N/A
Access to affordable and clean energy services	N/A
Human and institutional capacity	N/A
Quantitative employment and income generation	N/A
Balance of payments and investment	Overseas investment (for the return of CER) plays fairly role during implementation of the program.
Technology transfer and technological self-reliance	Now, The general trend in Bangladesh is very common to use inferior cotton yarn, and use Enzyme wash to get a clean and smooth hand feel and finish to the garments. “Water saving technology”, Dr. Wolfram Engel.

これらから，当該 PoA はバングラデシュの持続可能な発展に貢献できると考えられる．

6.2 今後の広い意味でのコベネフィッツ評価の方向性に関して

上記 Gold Standard の評価の他，さまざまな SD 評価手法がある．少なくとも「言葉の面では」コベネフィッツはそれらを包含したいわば SD とほぼ同義の概念となる．

これらを区別することに大きな意味はないため，両方を統一して，かつ系統立てた扱いと手法開発（既存の他団体の手法の改良）が望まれる．

また，その結果の利用方法が明確でないため，「利用方法」自体の再検討も行う必要があるであろう．

III.　資料編

- PoA-DD/CPA-DD (generic), CPA-DD (specific)
- 現地調査報告書
- 省エネ診断レポート

**PROGRAMME DESIGN DOCUMENT FORM FOR CDM PROGRAMMES OF ACTIVITIES
(F-CDM-PoA-DD)
Version 02.0**

PROGRAMME OF ACTIVITIES DESIGN DOCUMENT (PoA-DD)

PART I. Programme of activities (PoA)

SECTION A. General description of PoA

A.1. Title of the PoA

Energy and Water Saving Promotion Programme for Textile Dyeing Process of Bangladesh Textile and Garment Industries

Version: 3.0
Date: 28/11/2012

A.2. Purpose and general description of the PoA

The purpose of the PoA promotes energy and water saving through optimizing the process from yarn to fabric on textile dyeing process that is the most water and energy consuming process in a textile and garment factory.

The textile and garments industry has been leading Bangladesh economy since early 1990s. Garments are the country's biggest export products making up about three quarters of total exports, and the industry is a symbol of the country's dynamism in the world economy. The number of garment factories has increased steadily and the textile and garment industry also has been increasingly becoming the most energy and water consuming sector. Bangladesh is facing water and energy scarcity; in the capital, the people are suffering serious waters crisis due to frequent load shedding, drastic fall in ground water level and deep tube wells. Therefore, promoting water and energy saving measures in the textile and garment industry is recognized to be important and urgent.

The PoA will reduce energy and water consumption in textile dyeing and finishing process through optimizing dyeing process from yarn to fabric including promoting high quality yarns and introducing direct dyeing, new generation reactive dyeing and other new dyes according to factories and buyers requirements. The technologies and know-hows will be introduced and promoted by Green Project Water Saving Technology (W.S.T), voluntarily as the W.S.T was established with a vision of promoting the water and energy saving technologies in Bangladesh Textile and Garment industry.

The PoA is a voluntary action promoted by the W.S.T. The W.S.T is the coordinating/managing entity (CME) of the PoA and responsible for overall supervising and managing the PoA. PEAR is the PoA developer and CER buyer. The PEAR also supports the W.S.T on their management.

The PoA also aims to contribute environment and resources conservation significantly through water saving and CO_2 emission reductions.

The first CPA of the PoA targets the Textile and Garment factory of the Grameen Knitwear, Ltd. which supports and closely works with the CME.

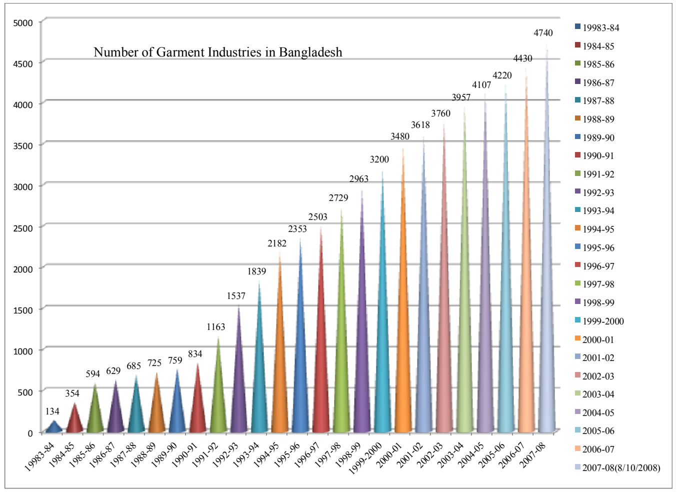

Figure 1. Increasing Trend of the Garment Factories in Bangladesh

A.3. CMEs and participants of PoA

W.S.T is the CME of the PoA which communicates with the Board.

Textile and Garment factories in Bangladesh are the implementers of CPAs under the PoA and participants of the PoA.

PEAR also is a participant of the PoA as being the CER buyer and the PoA developer.

A.4. Party (ies)

Name of Party involved (host) indicates a host Party	Private and/or public entity (ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Bangladesh (host)	Green Project W.S.T	No
Japan	PEAR Carbon Offset Initiative, Ltd.	No

A.5. Physical/ Geographical boundary of the PoA

The PoA covers nationwide Textile and Garment industries and then targets all Textile and Garment factories in Bangladesh.
Therefore, the geographical boundary of the PoA is the whole Bangladesh shown in the below.

Figure 2. The Boundary of the PoA (whole Bangladesh)

A.6. Technologies/measures

The CPAs under the PoA promote energy efficiency improvement the dyeing and finishing process of Textile and Garment industry. The energy efficiency improvement will be realized through dyeing process optimization from yarn to fabric by targeting dyeing machines and other machines such as stenters, dryers if necessary in Textile and Garment factories. Thus, type II: Energy efficiency improvement project activities that reduce energy consumption, on the demand side, with a maximum output of 60 GWh per year (or an appropriate equivalent) in any year of the crediting period is applicable for CPAs under the PoA. Specifically, the AMS-II.D (Energy efficiency and fuel switching measures for industrial facilities, version 12) will be applied for CPAs under the PoA for baseline and monitoring.

The process adopted in textile dyeing and finishing depends upon the fabric processed. The processes vary by different materials (cellulose (mainly cotton), Polyester and CVC (Blended fabrics)), different shades and different dyeing machines.

The process optimization includes inseparable two ways: one is yarn optimization such as using compact yarn with low TPI (twist per inch), super combed spun yarn of long staple fiber or processing yarn singeing and fabric singeing to avoid bio-polishing and improve the quality of fabric that save dyes, chemicals, water and energy through reducing dyeing time.

Another is dyeing process optimization according to existing conditions of factories such as promoting direct dyes, noncarcinogenic GOTS certified Sulphur Dyes, new generation of reactive dyes.

In Bangladesh, current dyeing practice for 100% cotton is classic reactive dyes.

Reactive dye is a dye that can react directly with the fabric. That means that a chemical reaction happens between the dye and the molecules of the fabric, effectively making the dye a part of the fabric. A reactive dye is able to create a bond with cellulose. Reactive dyes are categorized as cold (37 °C), warm (60 °C) and hot (82 °C), which refers to the temperatures required to cause the reaction. Warm reactive dyes are the most common.

The following is the dyeing chart of reactive dyeing for 100% cotton.

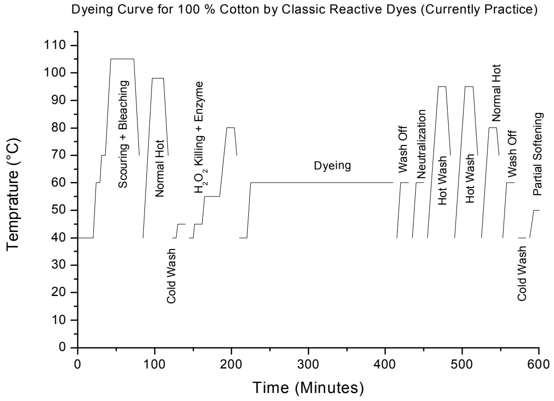

Figure 3. Dyeing Chart for 100% Cotton Classic Reactive Dyes

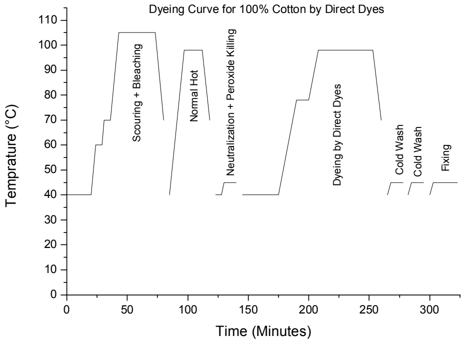

Figure 4. Dyeing Chart for 100% Cotton Direct Dyes

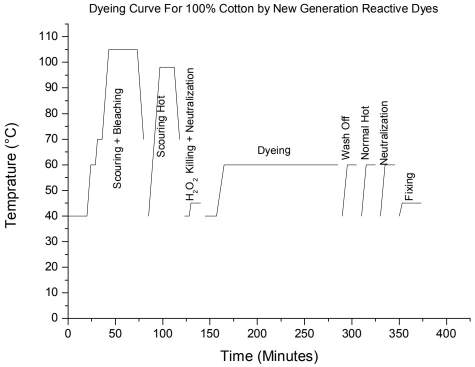

Figure 5. Dyeing Chart for 100% Cotton New Generation Reactive Dyes

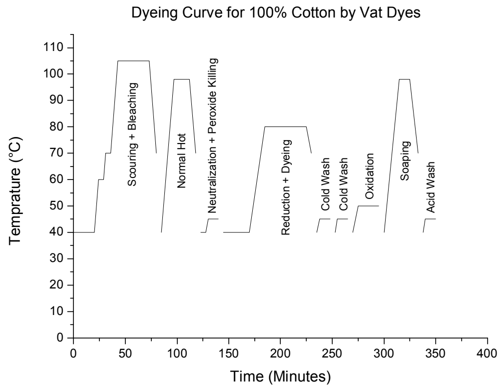

Figure 6. Dyeing Chart for 100% Cotton Vat Dyes

The reactive dyes needs 6–10 hours and that depends on the colour of fabric; generally dark colour needs more time. The CPAs under the PoA propose Directive dyes, new generation Reactive dyes, Vat dyes and Sulfur +Reactive Dyes according to factories requirements. The dyeing time, water and energy consumption of comparison of the dyeing methods is given as follows.

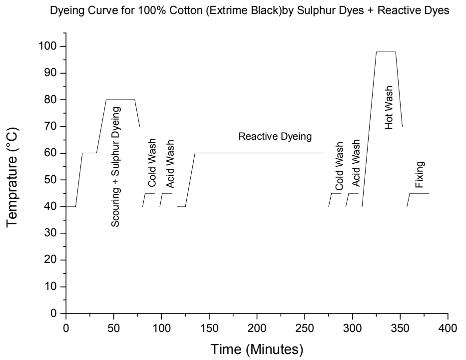

Figure 7. Dyeing Chart for 100% Cotton Sulphur + Reactive Dyes

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Table 1 Comparison of Proposed Technologies with Current Technology[1]

	Existing Reactive Dyes	**Direct Dyes**	**New Generation Reactive Dyes**	**Vat Dyes**	**Sulfer+ Reactive Dyes**
Number of Bathes	10~15	5~7	6~8	6~9	8~10
Time consumption (hours)	6~10	3~6	4~5	5~6	6~8
Water consumption (liter/kg fabric)	80~100	30~50	50~60	50~60	55~65
Power consumption (Kwh/kg fabric)	0.5	0.15	0.18	0.18	0.24
Steam consumption (kg-steam/kg fabric)	7.6	3.1	3.6	3.6	4.8

When a dye is applied directly to the fabric without the aid of an affixing agent, it is called direct dyeing. In this method, the dyestuff is either fermented (for natural dye) or chemically reduced (for synthetic vat and sulphur dyes) before being applied.

High quality yarns are required to avoid bio-polishing or enzyme washing. It is noted that the technologies are applied to where they fit to keep without deteriorating the quality of fabrics or it does not mean that one can apply for all colours.

As shown in the table above the direct dyeing reduces dyeing time significantly that in turn leads energy and water saving.

For the CVC, the dominant practice is disperse and classic reactive dyes in Bangladesh. The following is the dyeing chart for CVC.

The current disperse and reactive dyes needs 10~14 hours and that depends on the colour of fabric; the case of cotton, generally dark colour needs more time

Against this current dominant practice, the PoA proposes one bath CVC dyes and Scour dyes.

The following are the dyeing charts for the proposed technologies.

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[1] This is a simple comparison. All the data given above are not constant; it depends upon the dyeing machine liquor ratio, depth and type of shade, Fabric composition, Fabrications etc.

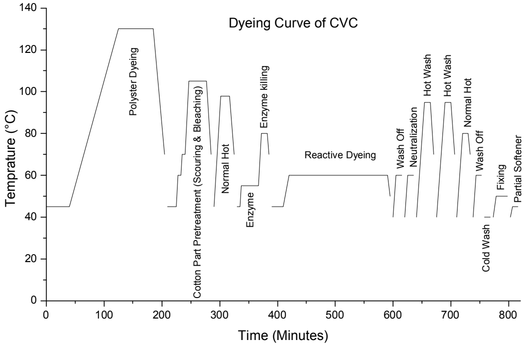

Figure 8. Dyeing Chart for Current CVC Dyes

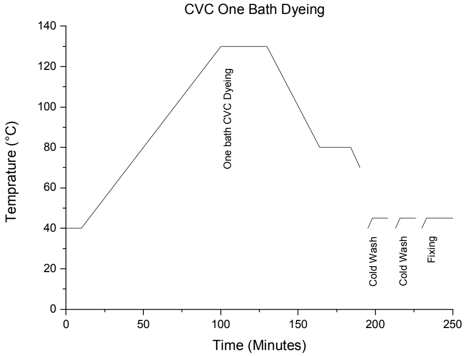

Figure 9. Dyeing Chart for One-Bath Dyes

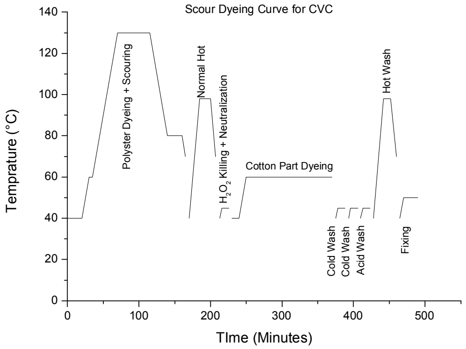

Figure 10. Dyeing Chart for Scour Dyes

Table 2 Comparisons of Proposed Technologies with Current Technology[2]

	Current Disperse and Reactive Dyes	**One Bath Dyes**	**Scour Dyes**
Number of Bathes	15~18	3~5	10~12
Time consumption (hours)	10~14	3~5	7~10
Water consumption (liter/kg fabric)	100~130	25~35	60~100
Power consumption (Kwh/kg fabric)	0.75	0.16	0.57
Steam consumption (kg-steam/kg fabric)	11.2	3.7	8.9

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[2] This is a simple comparison. All the data given above are not constant; it depends upon the dyeing machine liquor ratio, depth and type of shade, Fabric composition, Fabrications etc.

For the case of polyesters, current dyeing practice is disperse dyes. The proposed dyes for polyester is cationic dyes.

The technologies explained above are promoted as a package and tailored to factories by the W.S.T through conducting audits towards targeted factories.

A.7. Public funding of PoA

The PoA does not depend on any public funding given that all of the activities are by private companies. In case any CPA under this PoA avails of public funding, it will be required to provide in its CPA-DD that no official development assistance is diverted to the public funding.

SECTION B. Demonstration of additionality and development of eligibility criteria

B.1. Demonstration of additionality for PoA

The proposed PoA is a voluntary coordinated action by the CME as mentioned before the W.S.T was established for promoting the water and energy saving technologies in Bangladesh Textile and Garment industry. The implementation of the PoA and associated CPAs needed technologies initiated/led by W.S.T and commercial incentives to encourage coordinated voluntary participation by each Textile and Garment factory. In general, the commercial incentives for the CPA are expected to be in the forms of energy and water use cost savings and potential CDM revenues. The commercial incentives from technologies under the PoA is instructed and demonstrated by CME to convince factories participating the PoA.

The PoA started with a vision to make it as a CDM PoA and individual CPAs would never be implemented in the absence of the initiative and incentives mentioned above.

As dominant common dyeing practice for cellulose (mainly cotton) in Bangladesh is reactive dyeing with medium quality yarns thus the energy and water saving technologies are hardly disseminated without efforts of the CME. Hence, avoidance of anthropogenic GHG emissions would have not occurred in absence of this PoA; current practices would be used continuously.

The demonstration of additionality for each CPA will be provided in the individual CPA-DD through meeting the eligibility criteria.

B.2. Eligibility criteria for inclusion of a CPA in the PoA

The CME has established the eligibility criteria in accordance with EB 65, Annex 3, “Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities” for the implementation of the PoA, as follows:

Table 3. Eligibility Criteria

No	Requirements for Eligibility Criteria	Eligibility Criteria	Conformity Yes or No
A	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA.	A.1 A CPA targets a textile and garment factory in Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
		A.2 The name and the address of the factory are defined	Each CPA will demonstrate the conformity of the eligibility criteria
B	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo)	B.1 A CPA is a new project which is not registered large scale CDM or SSC-CPA in the other PoA	Each CPA will demonstrate the conformity of the eligibility criteria
		B.2 There is unique identification of the target factory	Each CPA will demonstrate the conformity of the eligibility criteria
C	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	C.1 Is it possible to submit specification of technology/measure when the DOE validates or verify?	Each CPA will demonstrate the conformity of the eligibility criteria
D	Conditions to check the start date of the CPA through documentary evidence;	D.1 The start date of a CPA is not, or will not be, prior to the commencement of validation of the PoA.	Each CPA will demonstrate the conformity of the eligibility criteria
E	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs;	E.1 Does a CPA meet the applicability and other requirements of AMS- II.D as described in PoA-DD section B.3.	Each CPA will demonstrate the conformity of the eligibility criteria
F	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality	F.1 The achieved energy saving of a CPA at a scale of no more than 60 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
		F.2 If the achieved energy saving of a CPA is more than 60 GWh_{th} per year, a barrier due to prevailing practice is applied. The prevailing dyeing practice in Bangladesh Textile and Garment industry is reactive	Each CPA will demonstrate the conformity of the eligibility

		dyes for cellulose; disperse dyes for CVC and polyester.	criteria
G	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	G.1 A CPA performs local stakeholder consultation before the inclusion of SSC-CPA.	Each CPA will demonstrate the conformity of the eligibility criteria
		G.2 A CPA does not need to performs the environmental impacts analysis according to the regulation of Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
H	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;	H.1 A CPA does not use any fund from Annex I parties	Each CPA will demonstrate the conformity of the eligibility criteria
		H.2 If a CPA uses a fund from Annex I parties then it does not result in a diversion of official development assistance	Each CPA will demonstrate the conformity of the eligibility criteria
I	Where applicable, target group (e.g. domestic/commercial/industrial, rural/urban, grid-connected/off-grid) and distribution mechanisms (e.g. direct installation)	I.1 Not applicable	Not applicable
J	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys;	J.1 A CPA-DD applies 95/10 (confidence /precision) for any necessary survey according	Each CPA will demonstrate the conformity of the eligibility criteria
K	Where applicable, the conditions that ensure that CPA in aggregate meets the small-scale or micro-scale threshold criteria and remains within those thresholds throughout the crediting period of the CPA	The aggregate energy savings by a CPA does not exceed the equivalent of 180 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
L	Any SSC-CPA included in the PoA is not a de- bundled component of another CDM programme activity (CPA) or CDM project activity	L.1 Is a CPA confirmed to a single project, which is not a de-bundled component of another large-scale CPA or CDM project activity as per the latest guidance given in CDM EB?	Each CPA will demonstrate the conformity of the eligibility

			criteria
M	Crediting period of any CPA does not exceed the end date of the PoA.	M.1 Is the crediting period of a CPA is within the crediting period of the PoA?	Each CPA will demonstrate the conformity of the eligibility criteria

B.3. Application of methodologies

The methodology applied for CPA under the PoA is:

Scope No: 4
Sectoral scope: Energy Demand
Category: AMS-II.D. (Energy efficiency and fuel switching measures for industrial facilities)
Version: 12

The conformity of PoA in line with applicability conditions in the AMS-II.D is described in the following table.

Table 4. Baseline and Monitoring Methodology Applicability Demonstration

No	Applicable conditions of the Methodology	Conformity of CPAs
1	This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility/ies. This category covers project activities aimed primarily at energy efficiency;	Each CPA will target dyeing process of a garment factory to reduce energy and water consumption in the dyeing process through introducing energy and water saving technologies.
2	This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g., electricity and/or fossil fuel consumption).	The electricity and fossil fuel consumption for textile dyeing process can be measured directly through meters installed at corresponding points of energy an water supply lines.
3	This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	Each CPA under the PoA focuses on optimizing or changing textile dyeing process on dyeing machines and other machines. Then the target of the measures is clear; the impacts of the measures are controllable, distinguishable and visible from the dyeing machines performance charts and/or other meters.
4	The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GWh_e per year. A total saving of 60 GWh_e per year is equivalent to a maximal saving of 180 GWh_{th} per year in fuel input.	The aggregate energy savings of each CPA under the PoA is up to 60 GWh_e per year. Any overages happened would not be claimed for emission reduction.

SECTION C. Management system

(1) Generic description of the operation and management system:

W.S.T is responsible for collection of all necessary information from target factories directly and responsible for defining and inclusion of each CPA supported by PEAR.

Textile and Garment factories who voluntarily participate in the PoA have responsibility to provide necessary information for management of the PoA.

The factories will sign agreements (using a specific format) with the W.S.T to promise providing all the relevant information and undertaking the monitoring.

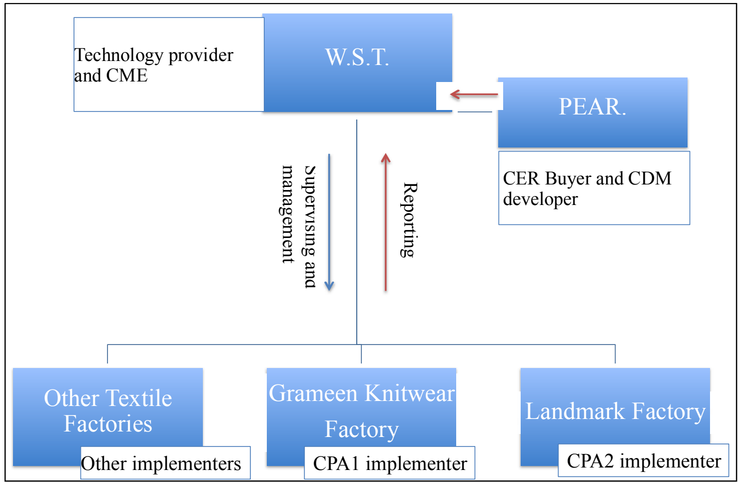

Figure 11. Managing and Reporting Structure of the PoA

(2) A record keeping system for each CPA under the PoA:

The record keeping system includes the method of data collection, the duty and roles of each player and the database including but not limited to schedule and ID number for each CPA, all necessary information/data of each factory in each CPA including but not limited to:

-- Names of factories and their addresses
-- ID numbers of the CPAs
-- Starting dates of projects operation
-- Number of dyeing machines and their capacity in each factory

-- Batch wise baseline electricity consumption for targeted dyeing machines
-- Batch wise baseline steam consumption for targeted dyeing machines
-- Batch wise baseline water consumption for targeted dyeing machines
-- Number of batches for machines for different dyeing process in the project
-- Batch wise electricity consumption for targeted machines
-- Batch wise steam consumption for targeted dyeing machines
-- Batch wise water consumption for targeted dyeing machines
-- Electricity consumption for targeted machines other dyeing machines
-- Steam consumption for targeted dyeing machines other than dyeing machines
-- Water consumption for targeted dyeing machines other than dyeing machines

It is noted that the management system does include other information than the required ones for CDM PoA. The W.S.T will consider which information/data are to be reported in addition to the ones needed for CDM.

Related responsibilities and tasks of participants under the record keeping system are described in the Table below.

It is noted that the process of definition and inclusion of each CPA is to be undertaken W.S.T supported by PEAR using the information of above-mentioned management system.

Table 5. Responsibilities and tasks of players involved in the PoA

	Players	Personnel	Processes

Coordination of the PoA including the process if inclusion of CPAs	W.S.T	CDM managing team supported by PEAR	- Supervise implementers and receives the relevant information provided by implementers. - Apply the registration of the PoA with UNFCCC CDM Executive Board as a focal point. - Develop a PoA management system and making continuous improvements of the system. - Carry out the management and coordination of PoA in accordance with the management system. - Select and contract CPA implementers; Make decision on whether to implement a specific CPA based on the proposal submitted by the CPA implementer. - Develop and update eligibility criteria for inclusion of CPAs. - Improve the PoA management system according to the latest methodology and standards. If there are new problems during the random check, the PoA management system should be improved.
		CDM technical advisory team	- Provide training and capacity development for personnel in the whole process of CPA implementers. - Carry out the technical review and control of inclusion of CPAs. - Review of the competencies of personnel involved in the process of inclusion of CPAs.
	Each CPA implementer	CDM managing team	- Submit a proposal about CPA implementation to CME for making decision. - Collect the initial information using standardized formats and transfer them into an electronic database. - Maintain all the records, documents and database in the process of CPA implementing, and make them available to CME for checking randomly and DOE for validation or verification. - Carry out monitoring action in accordance with monitoring plan.

Ex ante and ex post data collection	W.S.T	CDM technical advisory team	- Specify the required data/ information to be collected before start and/or during implementation of each CPA.
	Each CPA implementer		- Conduct data collection from its own factory.
Data storage and management	W.S.T	CDM technical advisory team	- Develop database format for CPAs. - Check the reported data from CPA each implementer. - Calculate emission reductions based on the data reported by implementers. - Implement data management of covered CPAs. - Compile and store data as a database.
	Each CPA implementer	CDM managing team	- Collect and compile data/information as electronic file. - Store the electronic and hard copy of the data and information. - Provide the electronic file to CME.
Communication and reporting	W.S.T	CDM managing team	- Coordinate between implementers and communicating with DOE and CDM EB
	Each CPA implementer	CDM managing team	- Report collected information to the W.S.T.
Training and capacity building	W.S.T	CDM technical advisory team	- Develop and establish training program for the implementers. - Implement seminars for implementers to meet the needs of the monitoring plan.
Quality assurance and verification	W.S.T	CDM technical advisory team	- Establish and maintain quality assurance system with a view to ensuring transparency and allowing for verification. - Prepare for, facilitate and co-ordinate verification process.
	Each CPA implementer	CDM managing team	- Implementers undertake regular check of meters and conduct calibration in accordance with the specifications and requirements. - Prepare backup ways to get data and information for the cases of data loss

(3) A system/procedure to avoid double accounting e.g., to avoid the case of including a new CPA that has been already registered either as a CDM project activity or as a CPA of another PoA:

The W.S.T technically reviews at the time of CPA inclusion that any biogas digester system under the CPA does not belong to another CPA under this PoA or another registered CDM project activity or another CDM PoA.
It is also checked whether there is any other CDM activity that targeted the same factory covered by the CPA proposed.

(4) The SSC-CPA included in the PoA is not a de-bundled component of another CPA or CDM project activity:

The W.S.T will follow the latest version of guidance provided by the Executive Board on "Occurrence of De-bundling under Programme of Activity" to identify whether a proposed CPA is a de- bundled component of a large scale activity.

(5) The provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the PoA:

Any CPA under the PoA is recommended and planned by the W.S.T and PEAR. Moreover, as explained in table above, under the record keeping system, the implementers are to have a contract to undertake any project activities under the PoA—under supervision by the W.S.T—are well aware of and have agreed to their activity under the PoA.

SECTION D. Duration of PoA
D.1. Start date of PoA

The start date of the PoA is the date in which the PoA-DD published for global stakeholder consultation.

D.2. Duration of the PoA

The duration of the PoA is 28 years 0 month

SECTION E. Environmental impacts
E.1. Level at which environmental analysis is undertaken

The dyeing process energy and water saving PoA is believed to have no any negative impacts on the environment.
The impact of each CAP under the PoA on the environment is identical in most extension regardless of location; therefore, Environmental Analysis is done at the PoA level.

E.2. Analysis of the environmental impacts

As the PoA focuses on process change or process optimization in the existing textile and garment factories that have had environmental clearance certificates and the PoA is seen as no any negative environmental impacts then an additional environmental impact assessments for PoA is not required.
The impact of the PoA on the environment in the whole process is believed to be positive, which is manifested in the following aspects:

(1) The project will contribute to ensure future water security in Bangladesh.
The underground water is the main source of drinking water in Bangladesh. However, for textile dyeing in Bangladesh garment industry, underground water also has been used dominantly. It has been figured out that the heavy lifting of underground water on a regular basis in so many places including Dhaka city is causing the underground water levels to dry up faster than is normal. The project promises to reduce underground water consumption for textile dyeing process significantly.

(2) The project will contribute to ease land subsidence having occurred.
It is reported that there are too many places in the country where the heavy withdrawal of underground waters have disturbed the soil layers and caused land subsidence. Even in the capital city and other cities of the country that depend disproportionately in the lifting of underground water for household and other uses, land subsidence is noted to be a serious consequence of the practice. Thus, from the preventing the disfigurement of land and its calamitous effects, a reducing consumption of underground water is an indispensable way.

SECTION F. Local stakeholder comments
F.1. Solicitation of comments from local stakeholders

The Local stakeholder consultation meeting was conducted at the PoA level as social and environmental impacts of the CPAs are seen to be identical regardless of target factories.

The PoA level Local Stakeholder Consultation Meeting was held at Uttara Club (Lotus Hall), Dhaka on 5th of November 2012 for having comments and opinions from local stakeholder from various sectors. Around 50 participants including Mr. Faruque Hassan, Vice President, BGMEA, delegates from Textile and Garment Factory and experts from Machinery Manufacturer were present in the meeting.

F.2. Summary of comments received

The comments were received during the meeting is summarized in the table as below.

Table 6. Questions and Comments Received

Stakeholder comment	Was comment taken into account (Yes/ No)?	Explanation (Why? How?)
Is this project can reduce the use of chemical & if yes how? (Mr. Mohammad Roqibul Islam from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH)	Clarification was given	This project can reduce the use of chemical for textile wet processing. Because in textile wet processing the chemicals are dozing in g/liter, so according to our proposed technology (in which 30-40 liters of water are used for each kg cotton fabric processing) we are using less amount of water then the existing system (100 liters of water for each kg fabric processing) that's how we are saving chemicals.
Does the concentration of chemical increase in ETP (Effluent Treatment Plant) after the implementation of the project? If increase then how you will control this? (Mr. Mohammad Roqibul Islam from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH)	Clarification was given	No our project does not increase the concentration of chemical in the ETP. So we don't need to control this matter in ETP.
Why you are working only on two-model factories? (Mr. Zaman from Jamuna Group)	Clarification was given	At present, we are actively working with the two factories (Grameen Knitwear Ltd. & Landmark Fabrics Limited) to register the programmatic CDM (PoA) as a CDM project. After registration the entire interested factory can be included to the programme.
How other factories can be a part of this Project and what are the criteria for this? (Mr. Zaman from Jamuna Group)	Clarification was given	Other factories also can be a part of this project as a CPA (Component Project Activity) after the PoA registered to be CDM project. Any textile and garment factory in Bangladesh can apply participation of the PoA through implementing water and energy technologies proposed by W.S.T. So please contact with W.S.T which will advise you on what kind of technologies will appropriate for your factory.
Does your technology can overcome the fastness problem of red and dark black? (Mr. Zaman from Jamuna Group)	Clarification was given	Our proposed technology can overcome this problem. By choosing the appropriate process of dyeing from our proposed options this problem can easily solved.
If we invite you, are you interested to come to our factory? (Mr. Zaman from Jamuna Group)	Yes	We are interested to work with factories who are believing and willing to apply our idea
May we take back the sustainable development matrix and return it by e-mail with full completion? (Mr. Sohag Miah from NIAGARA TEXTILES LTD)	Yes	You can complete the table after the meeting and send it back us with e-mail. And kind of continues inputs are welcome by e-mail and telephone.

F.3. Report on consideration of comments received

All questions and comments are responded to increase stakeholders understanding of the project.

Some factories' requirements of conducting audits on their factories for joining the project are accepted.

Some stakeholder's requests to complete the sustainable development matrix after the meeting are accepted also. Please refer to the table above for detailed responds for corresponding questions and comments.

SECTION G. Approval and authorization

The Letter of Approval from both host country (Bangladesh) and Japan will be received in due time.

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA

A.1. Purpose and general description of generic CPAs

The proposed small-scale Component Project Activity (CPA) would consist of introducing energy and water saving technology toward dyeing process of the Garment factories. The aim of the CPA is to contribute to the sustainable development of Bangladesh. The proposed SSC-CPA will reduce greenhouse gas emissions through the increase in energy efficiency as well as saving water consumption of the targeted garment factories in textile dyeing process.

SECTION B. Application of a baseline and monitoring methodology

B.1. Reference of the approved baseline and monitoring methodology (ies) selected

Baseline and Monitoring Methodology	Version 12 Sectoral Scope: 04 EB 51	AMS-II.D; Energy efficiency and fuel switching measures for industrial facilities
Tools and Guidelines	EB 65 Report, Annex 3, Version 01.0	Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities
	EB 65 Report, Annex 2, Version 2.0	Standard for sampling and surveys for CDM project activities and Programme of Activities
	EB 63 Report, Annex 24, Version 8	Attachment A to Appendix B of the simplified modalities and procedures for CDM small-scale project activities.
	EB 54 Report, Annex 13, Version 3	Guidelines on assessment of de-bundling for SSC project activities
	EB 67 Report, Annex 30, Version 02.0	GUIDELINES FOR COMPLETING THE PROGRAMME DESIGN DOCUMENT FORM FOR SMALL-SCALE CDM PROGRAMMES OF ACTIVITIES
	EB 66 Report, Annex 17, Version 01.0	GUIDELINES FOR COMPLETING THE COMPONENT PROJECT DESIGN DOCUMENT FORM FOR SMALL-SCALE COMPONENT PROJECT ACTIVITIES
	EB 68 Report, Annex 27,Version 09.0	GUIDELINES ON THE DEMONSTRATION OF ADDITIONALITY OF SMALL-SCALE PROJECT ACTIVITIES
	EB 68 Report, Annex 26,Version 04.0	GUIDELINES FOR DEMONSTRATING ADDITIONALITY OF MICROSCALE PROJECT ACTIVITIES

B.2. Application of methodology (ies)

The methodology of AMS-II.D (Energy efficiency and fuel switching measures for industrial facilities) is applied for CPAs under the PoA and a justification of applicability of the methodology is given in the table 7 below. CPA-specific conformity or compliance with the eligibility criteria will be assessed at the time of its inclusion.

Table 7. Baseline and Monitoring Methodology Applicability

No	Applicable conditions of the Methodology	Conformity of CPAs
1	This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility/ies. This category covers project activities aimed primarily at energy efficiency;	Each CPA will promote energy efficiency improvement for textile dyeing and finishing process of a textile and garment factory by targeting dyeing machine and other machines.
2	This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g., electricity and/or fossil fuel consumption).	The electricity and fossil fuel consumption for textile dyeing process can be measured or calculated through directly measured value by meters installed at corresponding points of energy an water supply lines.
3	This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	Each CPA under the PoA focuses on optimizing or changing textile dyeing process in dyeing machines or other machines. Then the target of the measures is clear; the impacts of the measures are controllable, distinguishable.

4	The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GWh$_e$ per year. A total saving of 60 GWh$_e$ per year is equivalent to a maximal saving of 180 GWh$_{th}$ per year in fuel input.	For every year during the crediting period, the aggregate energy savings of each CPA under the PoA will not exceed 180 GWh$_{th}$ per year. If during implementation and monitoring of each CPA goes beyond 180 GWh$_{th}$ in any year of the crediting period, the GHG emission reductions that can be claimed during this particular year shall be capped at the maximal saving of 180 GWh$_{th}$ estimated in the registered CPA-PDD for that year during the crediting period.

B.3. Sources and GHGs

The figure 12 below depicts related equipment, systems and flows of mass and energy in each CPA under the PoA. The project boundary of each CPA covers:

- The dyeing machines (pretreatment and dyeing)
- The other machines for finishing (Stenters, dryers)
- The water supply system
- The effluent treatment plant
- The geographical area covering energy sources such as boilers and captive generators at factories.

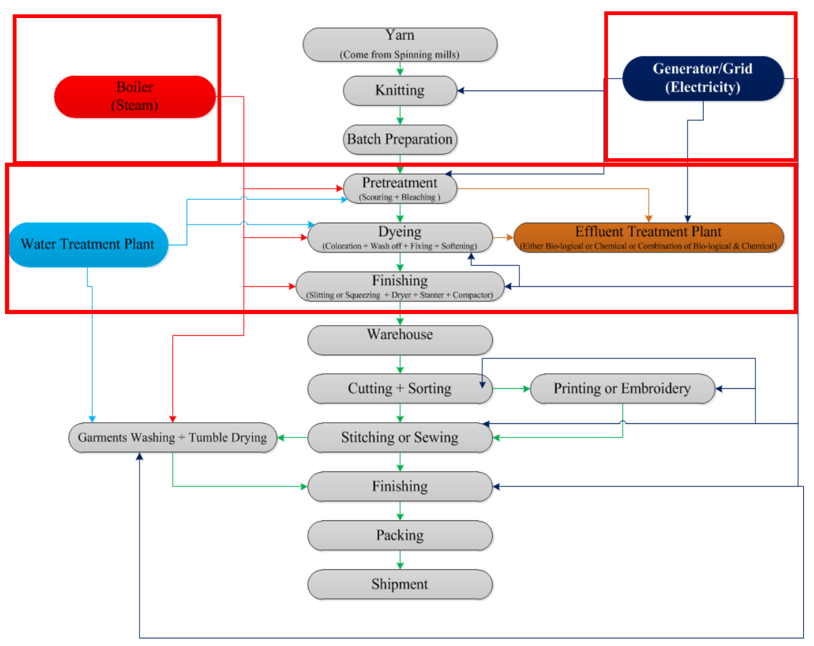

Figure 12. The Physically Delineation of Each CPA

As per the methodology, the sources of GHGs and GHGs considered in CPAs under the PoA are explained in the table below.

Source		GHGs	Included?	Justification/Explanation
Baseline	Electricity consumption of dyeing machines and other targeted machines in the dyeing processes (if any) for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Steam consumption of dyeing machines and other targeted machines in the dyeing processes (if any) for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Electricity consumption for pumping up water that used in dyeing processes for textile dyeing and pumping up waste water from a tank to tank in effluent treatment process	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
Project	Electricity consumption of dyeing machines and other targeted machines in the dyeing processes (if any) for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Steam consumption of dyeing machines and other targeted machines in the dyeing processes (if any) for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Electricity consumption for pumping up water that used in dyeing processes for textile dyeing and pumping up waste water from a tank to tank in effluent treatment process	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected

B.4. Description of baseline scenario

As per the methodology AMS II.D./version 12, the baseline scenario for the PoA is demonstrated as follows.

In the absence of the CDM project activity, the factories would continue to apply the current conventional dyeing practices to consume energy at historical average levels, until the time at which the dyeing practices would be likely to be replaced by the energy and water saving technologies in the absence of the CDM project activity.

B.5. Demonstration of eligibility for a generic CPA

All CPAs are eligible under the PoA, if the CPA complies with the following criteria:

No	Eligibility Criteria	Conformity Yes or No
1	A CPA targets a textile and garment factory in Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
2	The name and the address of the factory are defined	Each CPA will demonstrate the conformity of the eligibility criteria
3	A CPA is a new project which is not registered large scale CDM or SSC-CPA in the other PoA	Each CPA will demonstrate the conformity of the eligibility criteria
4	There is unique identification of the target factory	Each CPA will demonstrate the conformity of the eligibility criteria
5	Is it possible to submit specification of technology/measure when the DOE validates or verify?	Each CPA will demonstrate the conformity of the eligibility criteria
5	The start date of a CPA is not, or will not be, prior to the commencement of validation of the PoA.	Each CPA will demonstrate the conformity of the eligibility criteria
7	Does a CPA meet the applicability and other requirements of AMS- II.D as described in PoA-DD section B.3.	Each CPA will demonstrate the conformity of the eligibility criteria
8	The achieved energy saving of a CPA at a scale of no more than 60 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
9	If the above condition is not satisfied, a barrier due to prevailing practice in Bangladesh Textile and Garment industry that is reactive dyes for cellulose; disperse dyes for CVC and polyester would prevent occurrence of CPAs.	Each CPA will demonstrate the conformity of the eligibility criteria
10	A CPA performs local stakeholder consultation before the inclusion of SSC-CPA.	Each CPA will demonstrate the conformity of the eligibility criteria
11	A CPA does not need to performs the environmental impacts analysis according to the regulation of Bangladesh	Each CPA will demonstrate the conformity of the eligibility criteria
12	A CPA does not use any fund from Annex I parties	Each CPA will demonstrate the conformity of the eligibility criteria
13	If a CPA uses a fund from Annex I parties then it does not result in a diversion of official development assistance	Each CPA will demonstrate the conformity of the eligibility criteria
14	A CPA-DD applies 95/10 (confidence /precision) for any necessary survey according	Each CPA will demonstrate the conformity of the eligibility criteria
15	The aggregate energy savings by a CPA does not exceed the equivalent of 180 GWh_{th} per year	Each CPA will demonstrate the conformity of the eligibility criteria
16	Is a CPA confirmed to a single project, which is not a de-bundled component of another large-scale CPA or CDM project activity as	Each CPA will demonstrate the conformity of the

	per the latest guidance given in CDM EB?	eligibility criteria
17	Is the crediting period of a CPA is within the crediting period of the PoA?	Each CPA will demonstrate the conformity of the eligibility criteria

B.6. Estimation of emission reductions of a generic CPA

B.6.1. Explanation of methodological choices

Baseline Emissions

As mentioned before, the baseline scenario for the project is the continuation of current dyeing process (mainly conventional reactive dyeing) in garment factories.

According to the methodology ASM-II-D, the baseline emission can be calculated based on the following equation.

$$BE_y = (EC_{Dyeing,y}^{BL} + EC_{Water,y}^{BL}) \times EF_{CO2}^{BL,elec} + SC_y^{BL} \times EF_{CO2}^{BL,steam} \qquad (1)$$

Where:

BE_y	Baseline emissions in a year y (CO_2 ton/year)
$EC_{Dyeing,y}^{BL}$	Baseline electricity consumption by dyeing machines and other machines to which new/additional measure are introduced in the dyeing processes by the CPA in year y (kWh/year)
$EC_{Water,y}^{BL}$	Baseline electricity consumption by pumping of clean water that used in dyeing machines and pumping of waste water from tank to tank at effluent treatment plants in year y (kWh/year)
SC_y^{BL}	Baseline steam consumption by dyeing machines and other machines to which new/additional measure are introduced in the dyeing process by the CPA in year y (ton-steam/year)
$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity used (a grid emission factor or an emission factor of captive generator being used) (ton CO_2/MWh)
$EF_{CO2}^{BL,steam}$	CO_2 emission factor for steam generation at factories (ton CO_2/ton)

$$EC_{Dyeing,y}^{BL} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{BL,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} + \sum_m EC_{m,y}^{BL} \qquad (2)$$

Where:

$EC_{Dyeing,y}^{BL}$	Baseline electricity consumption by dyeing processes in year y (kWh/year)
$EC_{i,j,k,l}^{BL,Batch,dyeing}$	Historical average electricity consumption of a dyeing machine i for a batch in the baseline dyeing process for brightness of colour j material k at a load-type of l (kWh/batch)

$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a dyeing machine i in the project dyeing for brightness of color j material k at a load-type of l in a year y
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (j: light, medium, dark)
k	Type of textile being dyeing in the factory (k: cellulose, CVC and polyester)
l	Type of load for dyeing machine in a factory
EC_m^{BL}	Historical average electricity consumption of a targeted machine m in the factory by the project other than dyeing machine in a year y (kWh/year), if any
m	Targeted machine other than dying machines in a dyeing processes of the factory by the project, if any

$$EC_{Water,y}^{BL} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{fresh,water}^{BL,pumping} + \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{waste,water}^{BL,pumping} \times (N-1) + \sum_m WC_{m,y}^{BL} \times EC_{fresh,water}^{BL,pumping} + \sum_m WC_{m,y}^{BL} \times EC_{waste,water}^{BL,pumping} \times (N-1) \qquad (3)$$

Where:

$EC_{Water,y}^{BL}$	Baseline electricity consumption by pumping of water that used in dyeing machines in year y (kWh/year)
$WC_{i,j,k,l}^{BL,Batch}$	Historical average water consumption in machine i for a batch in the baseline dyeing process for colour j material k at a load of l (Litre/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine i in the project dyeing for color j material k at a load of l in a year y
$EC_{freash,water}^{BL,pumping}$	Historical average electricity consumption for pumping underground water (kWh/liter)
i	Type of dyeing machines in a factory
j	Color of textile being dyed in a factory (j: light, medium, dark)
k	Type of textile being dyeing in a factory (k: cellulose, CVC and polyester)
l	Different load for dyeing a machine in a factory
$WC_{m,y}^{BL}$	Historical average water consumption of a targeted machine m in the factory by the project other than dyeing machine in a year y (Litre/year)
m	Targeted machine other than dying machines in a dyeing processes of the factory by the project, if any
$EC_{waste,water}^{BL,pumping}$	Historical average electricity consumption for pumping waste water from tank to tank (kWh/liter)
N	Number of tanks at effluent treatment plant (ETP)

$$SC_y^{BL} = \sum_i \sum_j \sum_k \sum_l SC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} + \sum_m SC_{m,y}^{BL} \qquad (4)$$

Where:

SC_y^{BL}	Baseline steam consumption by dyeing processes in year y (ton/year)
$SC_{i,j,k,l}^{BL,Batch}$	Historical average steam consumption of a dyeing machine i for a batch in the baseline dyeing process for colour j material k at a load-type of l (ton-steam/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine i in the project dyeing for color j material k at a load-

	type of *l* in a year *y*
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in a factory
SC_m^{BL}	Historical average steam consumption of a targeted machine *m* in the factory by the project other than dyeing machine in a year *y* (kWh/year), if any
m	Targeted machine other than dying machine in a dyeing processes of the factory by the project, if any

$$EF_{CO2}^{BL,elec} = 0.584\ (Bangladesh\ grid\ emission\ factor)$$

$$or$$

$$= \frac{FC_{gen}^{BL,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{BL,fuel}} \qquad (5)$$

Where:

$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity used (a grid emission factor or process or an emission factor of captive generator being used) (ton CO_2/MWh)
$EG_{gen}^{BL,fuel}$	Historical average of electricity generated from generators (kWh/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{gen}^{BL.fuel}$	Historical fuel consumption average of generators (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)
$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{BL,steam}$$

$$= \frac{FC_{boiler}^{BL,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{BL,fuel}} \qquad (6)$$

Where:

$EF_{CO2}^{BL,steam}$	CO_2 emission factor for the steam generation (ton CO_2/ton steam)
$SP_{steam}^{BL,fuel}$	Historical amount of steam produced from boilers (ton-steam/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{steam}^{BL,fuel}$	Historical fuel consumption of boilers (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)
$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

Project Emissions

$$PE_y = (EC_{Dyeing,y}^{PJ} + EC_{Water,y}^{PJ}) \times EF_{CO2}^{PJ,elec} + SC_y^{PJ}$$
$$\times\ EF_{CO2}^{PJ,steam} \qquad (7)$$

Where:

PE_y	Project emission in a year y (CO_2 ton/year)
$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing machines and other machines which introduce new/additional measure in the dyeing processes by the CPA in year *y* (kWh/year)
$EC_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in year y (kWh/year)
SC_y^{PJ}	Project steam consumption by dyeing machines and other machines which introduce new/additional measure in the dyeing processes by the CPA in year (ton-steam /year)
$EF_{CO2}^{PJ,elec}$	CO_2 emission factor of electricity used (a grid emission factor or process or an emission factor of captive generator being used) (ton CO_2/MWh)
EF_{CO2}^{steam}	CO_2 emission factor for the steam generation (ton CO_2/ton)

$$EC_{Dyeing,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{PJ,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} + \sum_m EC_{m,y}^{PJ} \qquad (8)$$

Where:

$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing processes in year *y* (kWh/year)
$EC_{i,j,k,l}^{PJ,Batch,dyeing}$	Electricity consumption of a machine *i* for a batch in the project dyeing process for brightness of colour *j* material *k* at a load-type of *l* (kWh/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year y
i	Type of dyeing machines in a factory
j	Brightness of color of textile being dyed in a factory (*j*: light, medium, dark)
k	Type of textile being dyeing in a factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in a factory
EC_m^{PJ}	Project electricity consumption of a targeted machine *m* in the factory by the project other than dyeing machine in a year *y* (kWh/year), if any
m	Targeted machine other than dying machine in a dyeing processes of the factory by the project, if any

$$EC_{Water,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} \times\ EC_{fresh,water}^{PJ,pumping} + \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{PJ,Batch}$$
$$\times NB_{i,j,k,l,y}^{PJ} \times\ EC_{waste,water}^{PJ,pumping} \times (N-1) + \sum_m WC_{m,y}^{PJ} \times\ EC_{fresh,water}^{PJ,pumping} + \sum_m WC_{m,y}^{PJ}$$
$$\times\ EC_{waste,water}^{PJ,pumping} \times (N-1) \qquad (9)$$

Where:

$EC_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in year y (kWh/year)
$WC_{i,j,k,l}^{PJ,Batch}$	Water consumption in machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* (Litre/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
$EC_{fresh,water}^{PJ,pumping}$	Average electricity consumption for pumping underground water in the project in year y (kWh/liter)
i	Type of dyeing machines in a factory
j	Color of textile being dyed in a factory (*j*: light, medium, dark)
k	Type of textile being dyeing in a factory (*k*: cellulose, CVC and polyester)
l	Different load for dyeing a machine in a factory
$WC_{m,y}^{PJ}$	Project water consumption of a targeted machine *m* in the factory by the project other than dyeing machine in a year *y* (Litre/year), if any
m	Targeted machine other than dying machine in a dyeing processes of the factory by the project, if any
$EC_{waste,water}^{PJ,pumping}$	Electricity consumption for pumping waste water from tank to tank in the project in year y (kWh/liter)
N	Number of tanks at effluent treatment plant (ETP)

$$SC_y^{PJ} = \sum_i \sum_j \sum_k \sum_l SC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} + \sum_m SC_{m,y}^{PJ} \qquad (10)$$

Where:

SC_y^{BL}	Project steam consumption by dyeing processes in year *y* (ton-steam /year)
$SC_{i,j,k,l}^{BL,Batch}$	Steam consumption of a machine *i* for a batch in the baseline dyeing process for brightness of colour *j*, material *k* at a load-type of *l* (ton-steam /batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year *y*
i	Type of dyeing machines in a factory
j	Brightness of color of textile being dyed in a factory (*j*: light, medium, dark)
k	Type of textile being dyeing in a factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing a machine in a factory
SC_m^{PJ}	Project steam consumption of a targeted machine *m* in the factory by the project other than dyeing machine in a year *y* (kWh/year), if any
m	Targeted machine other than dying machine in a dyeing processes of the factory by the project, if any

$$EF_{CO2}^{PJ,elec} = 0.584\ (Bangladesh\ grid\ emission\ factor)$$

$$or$$

$$= \frac{FC_{gen}^{PJ,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{PJ,fuel}} \qquad (11)$$

Where:

$EF_{CO2}^{PJ,elec}$	CO_2 emission factor of electricity used (a grid emission factor or process or an emission factor of captive generator being used) (ton CO_2/MWh)
$EG_{gen}^{PJ,fuel}$	Amount of electricity generated from generators (kWh/year) in year y.
$FC_{gen}^{PJ,fuel}$	Amount fuel consumption of generators (m^3/year) in a year y.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)
$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{PJ,steam} = \frac{FC_{boiler}^{PJ,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{PJ,fuel}} \qquad (12)$$

Where:

$EF_{CO2}^{PJ,steam}$	CO_2 emission factor for the steam generation (ton CO_2/ton steam)
$SP_{steam}^{PJ,fuel}$	Amount of steam produced from boilers (ton-steam/year) in a year y.
$FC_{steam}^{PJ,fuel}$	Amount of fuel consumption of boilers (m^3/year) in a year y.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)
$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

Leakage

There are no leakage emissions identified for this type of project.
Therefore:

$$L = 0 \qquad (13)$$

Emission Reduction

$$ER_y = BE_y - PE_y \qquad (14)$$

Where:

ER_y	Emission reduction in year y (ton/year)
BE_y	Baseline emission in a year y (CO_2 ton/year)
PE_y	Project emission in a year y (CO_2 ton/year)

B.6.2. Data and parameters that are to be reported ex-ante

Data / Parameter	$EC_{i,j,k,l}^{BL,Batch,dyeing}$
Unit	kWh/batch
Description	Historical average electricity consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l*
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$WC_{i,j,k,l}^{BL,Batch}$
Unit	Litre/batch
Description	Historical average water consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l*
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EC_{fresh,water}^{BL,pumping}$
Unit	kWh/liter
Description	Historical average electricity consumption for pumping underground water
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EC_{waste,water}^{BL,pumping}$
Unit	kWh/liter
Description	Historical average electricity consumption for pumping waste water from tank to tank
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$SC_{i,j,k,l}^{BL,Batch}$
Unit	Ton-steam/batch
Description	Historical average steam consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l*
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$FC_{gen}^{BL,fuel}$
Unit	m^3/year
Description	Historical average amount of fuel consumption of generators for electricity generation. Data for the past three years is preferable; at least one-year vintage data is necessary.
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EG_{gen}^{BL,fuel}$
Unit	KWh/year
Description	Historical average of electricity generated from generators (kWh/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	NCV_{gen}^{fuel}
Unit	TJ/Gg
Description	Net caloric value of the fuel used for generators
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	46.5 for natural gas 41.4 for diesel
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	De_{gen}^{fuel}
Unit	Kg/m^3
Description	Density of the fuel for generators
Source of data	FINAL REPORT ON EMISSION INVENTORY, BANGLADESH COUNTRY STUDY, ASIA LEAST-COST GREENHOUSE GAS ABATEMENT STRATEGY (ALGAS)
Value(s) applied	0.717 for natural gas 0.84 for diesel
Choice of data or Measurement methods and procedures	Local data or default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EF_{CO2}^{fuel,gen}$
Unit	Kg-CO$_2$/TJ
Description	CO$_2$ emission factor of the fuel for generators
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	56,100 for natural gas 74,100 for diesel
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$SP_{steam}^{BL,fuel}$
Unit	Ton-steam/year
Description	Historical amount of steam produced from boilers. Data for the past three years is preferable; at least one-year vintage data is necessary.
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$FC_{steam}^{BL,fuel}$
Unit	m^3/year
Description	Historical fuel consumption of boilers. Data for the past three years is preferable; at least one-year vintage data is necessary.
Source of data	Project participants
Value(s) applied	Dependent on each CPA
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	NCV_{boiler}^{fuel}
Unit	TJ/Gg
Description	Net caloric value of the fuel used for boilers
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	46.5 for natural gas 41.4 for diesel
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	De_{gen}^{fuel}
Unit	kg/m^3
Description	Density of the fuel for boilers
Source of data	FINAL REPORT ON EMISSION INVENTORY, BANGLADESH COUNTRY STUDY, ASIA LEAST-COST GREENHOUSE GAS ABATEMENT STRATEGY (ALGAS)
Value(s) applied	0.72 for natural gas 0.84 for diesel
Choice of data or Measurement methods and procedures	Local data
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EF_{CO2}^{fuel,boiler}$
Unit	Kg-CO$_2$/TJ
Description	CO$_2$ emission factor of the fuel for boilers
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	56,100 for natural gas 74,100 for diesel
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

B.6.3. Ex-ante calculations of emission reductions

As per the formulae given in this PDD Part II Section B 6.2, the ex-ante calculations of the water and energy savings and emission reductions are explained on each CPA.

B.7. Application of the monitoring methodology and description of the monitoring plan

B.7.1. Data and parameters to be monitored by each generic CPA

Data / Parameter	$NB_{i,j,k,l,y}^{PJ}$
Unit	Number
Description	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Aggregation of daily records in factories
Monitoring frequency	Project participants collect daily-recorded data in factories monthly
QA/QC procedures	
Purpose of data	For calculating project electricity and water consumption
Additional comments	-

Data / Parameter	$EC_{i,j,k,l}^{PJ,Batch,dyeing}$
Unit	KWh/batch
Description	Electricity consumption of a machine *i* for a batch in the project dyeing process for color *j* material *k* at a load of *l* in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring through power meters installed at factories.
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Aggregation of daily records. Calibrations of power meters will be conducted as per related guidelines and instructions.
Purpose of data	For calculating project emission from electricity consumption
Additional comments	-

Data / Parameter	$WC_{i,j,k,l}^{PJ,Batch}$
Unit	Litre/batch
Description	Water consumption of a machine *i* for a batch in the project dyeing process for colour *j* material *k* at a load of *l*
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring through dyeing machines' water tanks with scales
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Aggregation of daily records and cross checks will be done through dye bath water ratio of dyeing processes.
Purpose of data	For calculating project emission from water consumption
Additional comments	-

Data / Parameter	$SC_{i,j,k,l}^{PJ,Batch}$
Unit	To-steam/batch
Description	Steam consumption of a machine *i* for a batch in the project dyeing process for colour *j* material *k* at a load of *l* (ton-steam /batch)
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring and calculating by project implementers as per dyeing charts programmed for dyeing machines.
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Comparison of measured data and calculated data will be conducted to justify the calculation as per dyeing charts. Steam meters will be calibrated as per related guidelines and instructions.
Purpose of data	For calculating project emission from steam consumption
Additional comments	-

Data / Parameter	$EC_{m,y}^{PJ}$
Unit	kWh/year
Description	Electricity consumption of a machine *m* other than a dyeing machine in the project dyeing process in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring through power meters installed at factories.
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Aggregation of daily records. Calibrations of power meters will be conducted as per related guidelines and instructions.
Purpose of data	For calculating project emission from electricity consumption
Additional comments	-

Data / Parameter	$WC_{m,y}^{PJ}$
Unit	Litre/year
Description	Water consumption of a machine *m* other than a dyeing machine in the project dyeing process in a year *y*
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring through machines' water tanks with scales
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Aggregation of daily records and cross checks will be done through dye bath water ratio of dyeing processes.
Purpose of data	For calculating project emission from water consumption
Additional comments	-

Data / Parameter	$SC^{PJ}_{m,y}$
Unit	To-steam/year
Description	Steam consumption of a machine *m* other than a dyeing machine in the project dyeing process in a year y (ton-steam /year)
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measuring and calculating by project implementers as per dyeing related programs for machines.
Monitoring frequency	Collect the data monthly from factories where the data recorded daily basis
QA/QC procedures	Comparison of measured data and calculated data will be conducted to justify the calculation as per programs Steam meters will be calibrated as per related guidelines and instructions.
Purpose of data	For calculating project emission from steam consumption
Additional comments	-

Data / Parameter	N
Unit	Number
Description	Number of tanks at ETP in a factory
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Site checking
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Conduct site check regularly
Purpose of data	For calculating project emission from water consumption and waste water treatment
Additional comments	-

Data / Parameter	$EC^{PJ,pumping}_{fresh,water}$
Unit	KWh/litre
Description	Electricity consumption for pumping underground water in a factory in a year y.
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured and calculated by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of daily records. Calibrations of power meters will be conducted as per related guidelines and instructions.
Purpose of data	For calculating project emission from water consumption
Additional comments	-

Data / Parameter	$EC^{PJ,pumping}_{waste,water}$
Unit	KWh/litre
Description	Electricity consumption for pumping waste water from tank to tank at ETP in a factory in a year y.
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured and calculated by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of daily records. Calibrations of power meters will be conducted as per related guidelines and instructions.
Purpose of data	For calculating project emission from water consumption
Additional comments	-

Data / Parameter	$EG^{PJ,fuel}_{gen}$
Unit	KWh/year
Description	Amount of electricity generated from generators in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured or collected by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of monthly records.
Purpose of data	For calculating CO_2 emission factor for electricity generation
Additional comments	-

Data / Parameter	$FC_{gen}^{PJ.fuel}$
Unit	m^3/year
Description	Amount of fuel consumed by generators for electricity generation in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured or collected by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of monthly records.
Purpose of data	For calculating CO_2 emission factor for electricity generation
Additional comments	-

Data / Parameter	$SP_{steam}^{PJ,fuel}$
Unit	Ton-steam/year
Description	Amount of steam produced by boilers in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured or collected by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of monthly records.
Purpose of data	For calculating CO_2 emission factor for steam generation
Additional comments	-

Data / Parameter	$FC_{steam}^{PJ,fuel}$
Unit	m^3/year
Description	Amount of fuel consumed by boilers for steam generation in a year y
Source of data	Project implementers
Value(s) applied	Depend on each CPA
Measurement methods and procedures	Measured or collected by project implementers
Monitoring frequency	Collect the data monthly from factories
QA/QC procedures	Aggregation of monthly records.
Purpose of data	For calculating CO_2 emission factor for steam generation
Additional comments	-

B.7.2. Description of the monitoring plan for a generic CPA

(1) Monitoring Framework

The monitoring management system is integrated part of the implementation management system as shown in section C.
The W.S.T will act as the overall supervisor and prepare a monitoring report periodically (typically annually) to the DOE by using the reports by factories.
The CPA implementers will undertake the monitoring (especially preparing the monthly and annual status report) based on the operation and monitoring manual prepared by The W.S.T. The WST has the responsibility to manage and operate all of the CPA.

(2) The Function of CME and CPA Implementers

The following table shows the roles of the CME and implementers for the monitoring.

	CME (Supported by PEAR)	Implementers (Textile and Garment Factories)
Monitoring management	- Develop the operation and monitoring manual for activities. - Develop and establish data collection and reporting system for parameters monitored in every CPAs. - Implement and manage monitoring of CPAs.	- Implement and manage monitoring of activities
Data collection	- Establish and maintain data collection systems for parameters monitored. - Check data quality and collection procedures regularly.	- Implement data collection; especially after the operation start. - Check internal data quality and collection procedures regularly
Data storage and management	- Develop database format of CPA. - Check the reported data from each CPAs. - Calculate emission reductions based on the data reported by the implementers. - Implement data management of CPAs. - Store and maintain records.	- Enter collected data to a computer database. - Implement data management of the activities. - Store and maintain records.
Communication and reporting	- Analyse data and compare project performances. - Prepare and forward monthly or annual reports.	- Report electronic data to the CME
CDM training and capacity building	- Develop and establish training program for implementers	- Implement simple internal training for staffs
Quality assurance and verification	- Establish and maintain quality assurance system with a view to ensuring transparency and	- Undertake regular check internal of data collection - All of information are recorded and

	allowing for verification. - Prepare for, facilitate and coordinate verification process.	reported to CME.

(3) Monitored Data

The data to be monitored are described in section B.7.1.

(4) Data Collection

Implementers will mainly carry out data collection. The role of CME in data collection is checking the quality of the data collected by implementers.

(5) Data Management

Data management is the most important step in the monitoring process to ensure transparent and credible emission reduction calculations.
Each implementer shall collect data described in section B.7.1 and archive these electronically using the common template developed by the CME. The electronic files and the hard copy shall be sent to CME.
The CME will develop an appropriate electronic template for archiving all data of every activity.
After reporting data from implementers, the CME shall check the data. If there are any errors found, they will be checked against original data.
The CME will calculate emission reductions for each CPA supported by PEAR, and store the outputs in hard disks as well as hard copy printouts.

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Appendix 1: Contact information on entity/individual responsible for the PoA

Organization	Green Project W.S.T
Street/P.O. Box	Sonargaon Janapath Road
Building	KC Tower
City	Dhaka
State/Region	Uttara
Postcode	1230
Country	Bangladesh
Telephone	880-2-8054034
Fax	880-2-8050395
E-mail	info@greenproject-wst.com
Website	www.greenproject-wst.com
Contact person	Wolfram Engel
Title	President and CEO
Salutation	Dr.
Last name	Engel
Middle name	
First name	Wolfram
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	engel.consulting.hk@gmail.com

Organization	PEAR Carbon Offset Initiative, Ltd.
Street/P.O. Box	1-10-11 Tsukuji
Building	1002 RATIO
City	Chuo-ku
State/Region	Tokyo
Postcode	104-0045
Country	Japan
Telephone	+81-3-3248-0557
Fax	+81-3-3248-0557
E-mail	n_matsuo@pear-carbon-offset.org
Website	www.pear-carbon-offset.org
Contact person	Naoki Matsuo
Title	CEO
Salutation	Dr.
Last name	Matsuo
Middle name	
First name	Naoki
Department	
Mobile	+81-90-9806-0723
Direct fax	
Direct tel.	
Personal e-mail	n_matsuo@pear-carbon-offset.org

Appendix 2: Affirmation regarding public funding

The PoA does not depend on any public funding. In case any CPA under this PoA avails of public funding, it will be required to provide in its CPA-DD that no official development assistance is diverted to the public funding.

Appendix 3: Application of methodology (ies)

The applicability conditions are demonstrated in section B.2 of this PoA-DD

Appendix 4: Further background information on ex ante calculation of emission reductions

Ex-ante calculation of emission reductions is done separately for each CPA.

Appendix 5: Further background information on the monitoring plan

Please refer to B.7.2 of the PoA-DD.

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History of the document

Version	Date	Nature of revision(s)
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the programme design document form for CDM programmes of activities" (EB 66, Annex 12).
01	EB33, Annex 41 27 July 2007	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		

COMPONENT PROJECT ACTIVITY DESIGN DOCUMENT FORM (F-CDM-CPA-DD)
Version 02.0

COMPONENT PROJECT ACTIVITIES DESIGN DOCUMENT (CPA-DD)

SECTION A. General description of CPA

A.1. Title of the proposed or registered PoA

Energy and Water Saving Promotion Programme for Textile Dyeing Process of Bangladesh Textile and Garment Industries

A.2. Title of the CPA

Energy and Water Saving Promotion for Textile Dyeing Process of Grameen Knitwear Textile and Garment Factory in Bangladesh

Version: 2.0
Date: 28/11/2012

A.3. Description of the CPA

The CPA targets Textile and Garment factory of Grameen Knitwear Limited (GK), established in 1997, is a 100% export oriented factory located in the Export Processing Zone (DEPZ) in Savar Dhaka. GK has a dyeing capacity of 8 ton/day. As it is located in DEPZ area, the factory has to pay bill for each cubic water they are using not only for fresh water but also for effluent water they are discharging to the central ETP (effluent treatment plant) of DEPZ after treating the waster water in their own ETP. GK also has to buy electricity from United Power Generation and Distribution Company, Ltd. that provides power to the DEPZ.

The CPA aims to save water and energy in the factory through optimizing textile dyeing process in dyeing machines through introducing high quality cotton yarn, changing dyeing process from current reactive dyes to directive dyes and other appropriate dyeing ways according to requirements of buyers. The GK, with the help of W.S.T takes a lead by introducing water and energy saving technology to its own factory through the CPA under the PoA by introducing directive dyes for cottons with proposing high quality yarn, one bath dyes for CVCs and cationic dyes for polyesters.

The baseline scenario is the continuation of current dyeing practices in the factory that are reactive dyes for cotton and disperse dyes for CVC and polyester that is the most dominant dyeing practice in Bangladesh textile and garment industry.

The CPA will contribute to sustainable development in the host country through the following social and environmental benefits:

- The project will contribute to ensure future water security in Bangladesh through reducing underground water consumption for textile dyeing process significantly.
- The project will contribute to ease land subsidence having occurred in Dhaka area, as the reducing consumption of underground water is an indispensable way for preventing the disfigurement of land and its calamitous effects.

A.4. Entity/individual responsible for CPA

The Grameen Knitwear Ltd. (GK) is the implementer of the CPA.

A.5. Technical description of the CPA

As mentioned before, the CPA targets Textile and Garment factory of the GK and promotes process optimization from yarn to fabric for textile dyeing. The CPA mainly focuses on the dyeing machines at the factory.

The layout of dyeing and finishing section of the factory is given in the figure 1 below. As shown in the layout of the factory, the factory has 5 dyeing machines they are Sclavos jet dyeing machines on which dyes with a bath ratio of 1:8 and overflow rinsing (no stop process for drain and fill with four nozzles and 180 litre water/min per nozzle) have been conducted. The table 1 below shows the information about the dyeing machines.

Table 1. Dyeing Machines in the Factory

				
Athena-H	**VAT-4**	**VHT-3**	**VHT-1**	**VHT-4**
1000kg	720 kg	540kg	180kg	720kg
2006	1998	1998	1998	2003
CVC/PET/C100	CVC/PET/C100	Cotton only	CVC/PET/C100	CVC/PET/C100

The steams need for the dyeing and finishing process being provided by 4 boilers at the factory. Among the 4 boilers, 2 of them (boiler 1 and 2 in the figure above) exclusively have provided steams for dyeing and finishing section. The following table 2 shows information about the boilers in the factory.

Table 2. Boilers Information in the Factory

Item	Unit	Boiler 01	Boiler 02	Boiler 03	Boiler 04
Manufacture year:	-	1998	1998	2003	2006
Brand name	-	COCHRAN	COCHRAN	COCHRAN	COCHRAN
Origin	-	UK	UK	UK	UK
Types	-	Fire tube	Fire tube	Fire tube: Diesel fuel	Fire tube: Diesel fuel
Steam Generating Capacity	Kg/hr	3,630	4,535	1,500	5,000
Design pressure	bar	12	12	12	12
Working Pressure	bar	10	10	10	10
Fuel (Gas) Consumption	M3/hr (L /hr)	259	324	11	(353)
	M3/Day (L./month)	6,206	7,781	1,114	(3,528)
Remarks				Operation time（10hr/day) (For garment ironing)	For back up (Maximum operation time is 10hr/month)

The lifetime of Sclavos dyeing machines are said to be 25 years. As the oldest machines in the factory are 14 years old, the average life expectancy of dyeing machines in the factory is 15 years.

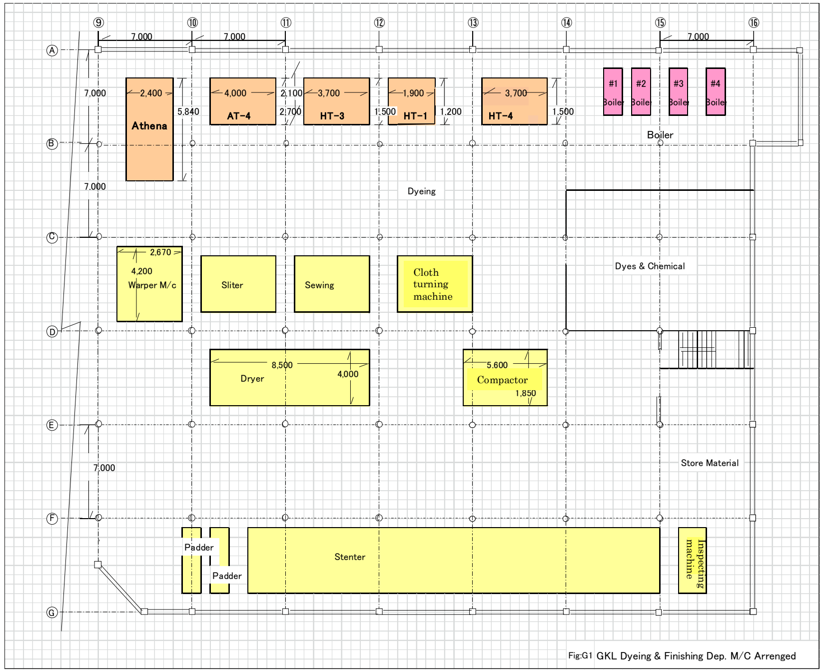

Fig:G1 GKL Dyeing & Finishing Dep. M/C Arrenged

Figure 1. The Layout of the Factory

The CPA does not intend to change or replace any facilities having been used in the factory. The facilities and systems like dyeing machines, boilers, water softening and effluent treatment systems are identical in the both baseline and project scenario. The energy and mass flows of the CPA and related facilities that are identical for both baseline and project scenario are shown in the figure 2 below.

The baseline scenario of the CPA is a continuation of the current dyeing practices such as reactive dyes with enzyme for cotton, reactive+ disperse for CVCs and disperse dyes for polyesters.

The CPA intrudes to use Combed Cotton Yarn with Low Twist instead of inferior cotton yarn used in most factories to avoid enzyme wash practiced in the factory. At the same time, the CPA introduce direct dyes, new generation Reactive dyes, Vat dyes and Sulfur +Reactive Dyes for cotton according to buyers requirement for shades. On the other hand, for the CVC, one batch or scour dyes and for polyester the cationic dyes are introduced instead of current disperse dyes.

The measures introduced by the CPA reduce dyes and chemicals need for a batch so that reduce water consumption for a match. The reduction of water consumption for the batch results in significant reduction of dyeing time for the batch. Obviously, reduction of electricity and steam consumption for the batch can be obtained through reduction of the dyeing time of the batch.

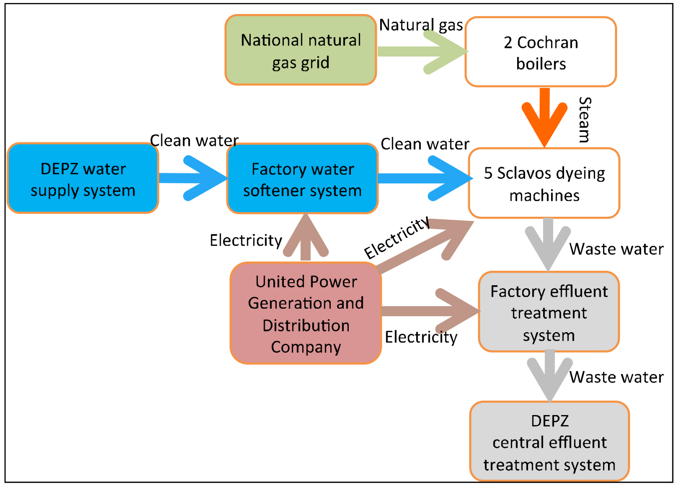

Figure 2. Energy and Mass Flows in the CPA

Thus, GHG (mainly CO_2) emission reduction from the CPA is realized from reduction of electricity consumption and steam consumption of dyeing machine for a batch. Meanwhile a reduction of electricity consumption for pumping groundwater and pumping waster water from tank to tank at the ETP can also be reached.

Clean water for the factory is from a water supply system of the DEPZ, which extracts groundwater with pumps. And waste water from the dyeing process goes to the factory’s own ETP before discharged to central ETP of the DEPZ.

However, the pumping of wastewater from tank to tank in the factory is seen to consume not much electricity as the total dynamic heads between tanks at the factory’s ETP are significant as shown in the figure 3 above. Therefore, the impact of the CPA on this part will be neglected.

So far, the factory has not installed meters such as electric meters and steam flow meters for machines for energy management; the CPA will install electric meters and steam flow meters to each machine for monitoring electricity and steam consumption of dyeing machines for each batch.

For monitoring electricity consumption of dyeing machines, kWh meters will be installed at the easy visible points of power lines to the machines. For monitoring steam consumption of dyeing machines, clamp-on ultrasonic flow meters are under consideration for installing at the appropriate points of steam pipes to the machines. The clamp-on ultrasonic flow meters are non-intrusive and no interruption in factory operation during installation and calibration.

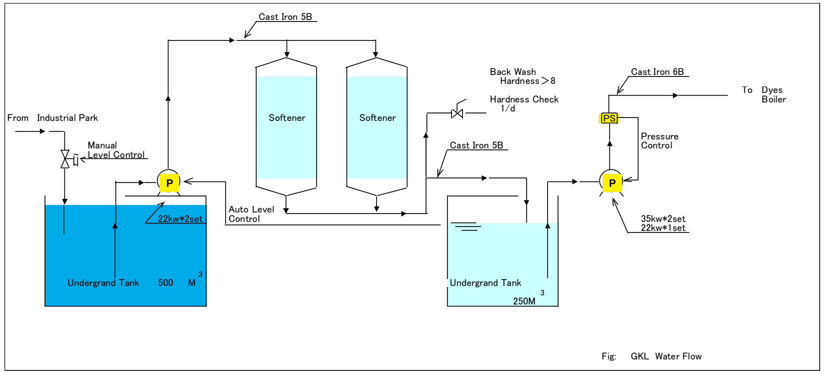

Figure 3. Water Softer System of the Factory

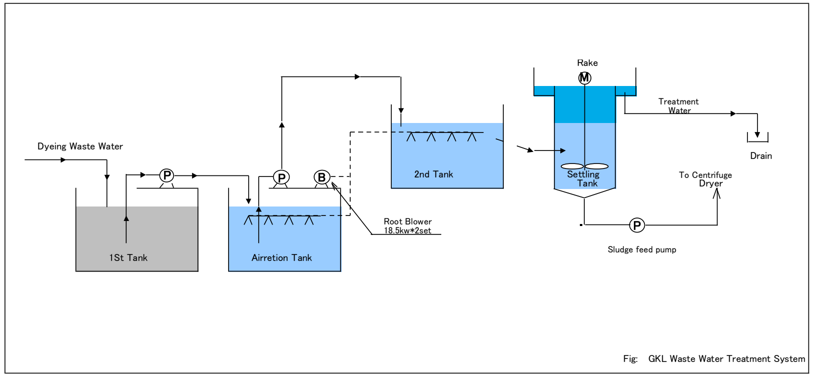

Figure 4. Effluent Treatment Plant of the Factory

For the factory, in the case of 100% cotton in dark, it is estimated that the CPA (good quality yarn and directive dyes) may cut water and steam consumption by 50% and electricity consumption by 75% through reducing dyeing time from 8 hours to 3 hours for a batch.

A.6. Party (ies)

Name of Party involved (host) indicates a host Party	**Private and/or public entity (ies) CPA implementer(s) (as applicable)**	**Indicate if the Party involved wishes to be considered as CPA implementer (Yes/No)**
Bangladesh (host)	Grameen Knitwear, Ltd. Green Project W.S.T	No
Japan	PEAR Carbon Offset Initiative, Ltd.	No

A.7. Geographic reference or other means of identification

The Textile and Garment factory of the Grameen Knitwear Ltd. is located in DEPZ (23°56'44"N 90°16'47"E) that is 35 km from Dhaka city centre and 25 km from International Airport. The factory's address is PLOT-102, 103, 126 and 127, DEPZ, Ganakbari, Savar, Dhaka.

Figure 5. Geographic Reference of the Factory

A.8. Duration of the CPA

A.8.1. Start date of the CPA

The start date of the CPA is 2/12/2012 on which the water and energy saving technologies duly start to be implemented in the factory.

A.8.2. Expected operational lifetime of the CPA

15 years 0 month

A.9. Choice of the crediting period and related information

Fixed crediting period is chosen.

A.9.1. Start date of the crediting period

01/06/2013 or the date of registration of the PoA, whichever is later

A.9.2. Length of the crediting period

The duration of crediting period of the CPA is 10 years 0 month and it is limited to the end date of the PoA regardless of when the CPA was added.

A.10. Estimated amount of GHG emission reductions

Emission reductions during the crediting period	
Years	**Annual GHG emission reductions (in tonnes of CO_2e) for each year**
01/06/2013	6,368
01/06/2014	6,368
01/06/2015	6,368
01/06/2016	6,368
01/06/2017	6,368
01/06/2018	6,368
01/06/2019	6,368
01/06/2020	6,368
01/06/2021	6,368
01/06/2022	6,836
Total number of crediting years	10 years
Annual average GHG emission reductions over the crediting period	6,836
Total estimated reductions (tonnes of CO_2e)	68,360

A.11. Public funding of the CPA

No public fund is used for the CPA

A.12. Debundling of small-scale component project activities

According to "GUIDANCE FOR DETERMINING THE OCCURRENCE OF DEBUNDLING UNDER A PROGRAMME OF ACTIVITIES (PoA), version 03.0", a proposed small-scale CPA of a PoA shall be deemed to be a de-bundled component of a large scale activity if there is already an activity, [1]which satisfies both conditions (a) and (b) below:

(a) Has the same activity implementer as the proposed small scale CPA or has a coordinating or managing entity, which also manages a large scale PoA of the same technology/measure, and;

(b) The boundary is within 1 km of the boundary of the proposed small-scale CPA, at the closest point.

So far, in Bangladesh, there has been no any registered small-scale CPA of a PoA or proposed small-scale CPA of a PoA or a registered small-scale CDM project is implemented by the Grameen Knitwear or coordinated by W.S.T and also there has been no any registered small-scale CPA of a PoA or proposed

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[1] Which may be a (i) registered small-scale CPA of a PoA, (ii) an application to register another small-scale CPA of a PoA or (iii) another registered CDM project activity.

small-scale CPA of a PoA or a registered small-scale CDM project within 1 km of the boundary of the CPA. Therefore, the CPA is not a de-bundled component of a large scale activity.

A.13. Confirmation for CPA

There have been no CDM project activities or PoAs relating to textile and garment industry in Bangladesh and further more, there have been no any other CDM project activities or PoAs proposed or implemented by the CME in Bangladesh. Thus it follows that the proposed CPA is neither registered as an individual CDM project activity or is part of another registered PoA.

SECTION B. Environmental analysis

B.1. Analysis of the environmental impacts

The environmental impacts have been analyzed at the PoA level.

SECTION C. Local stakeholder comments

C.1. Solicitation of comments from local stakeholders

A PoA level Local Stakeholder Consultation Meeting was held at Uttara Club (Lotus Hall), Dhaka on 5th of November 2012.

C.2. Summary of comments received

The local stakeholder consultation is provided at the PoA level. Please refer to F.2 of the PoA-DD.

C.3. Report on consideration of comments received

The local stakeholder consultation is provided at the PoA level. Please refer to F.3 of the PoA-DD.

SECTION D. Eligibility of CPA and estimation of emissions reductions

D.1. Title and reference of the approved baseline and monitoring methodology (ies) selected:

The methodology of AMS-II.D (Energy efficiency and fuel switching measures for industrial facilities, version 12) is applied for the CPA.

D.2. Application of methodology (ies)

The justification of applicability of the methodology is given in the table below.

No	Applicable conditions of the Methodology	Conformity of the CPA
1	This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility/ies. This category covers project activities aimed primarily at energy efficiency;	The CPA targets Textile and Garment factory to improve energy efficiency on textile dyeing process through introducing water and energy saving technologies
2	This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g., electricity and/or fossil fuel consumption).	The electricity and fossil fuel consumption for textile dyeing process can be measured or calculated through directly measured value by meters installed at corresponding points of energy an water supply lines.
3	This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	The CPA focuses on dyeing machines. Then the target of the measures is clear; the impacts of the measures are distinguishable.
4	The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GWh_e per year. A total saving of 60 GWh_e per year is equivalent to a maximal saving of 180 GWh_{th} per year in fuel input.	For every year during the crediting period, the aggregate energy savings of the CPA under the PoA will not exceed 180 GWh_{th} per year. The aggregate energy savings of the CPA is estimated to be up to 15GWh_{th}/year for the first crediting period.

As the CPA can satisfy all applicability and other conditions of the AMS-II.D, then the methodology can be applied for the CPA.

D.3. Sources and GHGs

The proposed CPA is located in the geographical boundary of the PoA as it targets the factory of GK that located in DEPZ of Bangladesh and the boundary of the CPA specifically covers the following facilities and systems in the factory.

- The dyeing machines
- The effluent treatment plant of the factory
- The boilers

Besides that the spatial extent of the boundary of the CPA includes the water supply system of the DEPZ from where the factory is gaining clean water and United Power Generation & Distribution Company, which is also located in the DEPZ and provide electricity for the factory.

The figure 5 below depicts the points of emission sources and monitoring and delineates the geographical boundary of the CPA.

However, electricity consumption for pumping waster water from one tank to another tank at the ETP of the factory is seen to be negligible as the heads between the tanks are not significant.

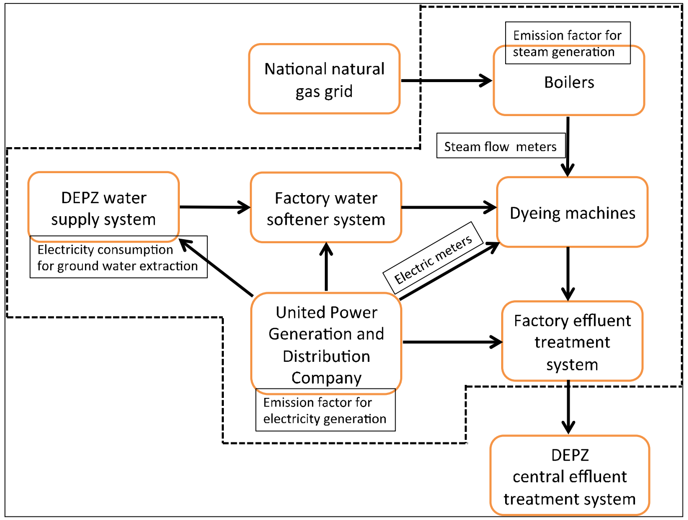


Figure 6. Physical Delineation of the CPA

Source		GHGs	Included?	Justification/Explanation
Baseline	Electricity consumption of dyeing machines for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Steam consumption of dyeing machines for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Electricity consumption for pumping up water that used in dyeing processes for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
Project	Electricity consumption of dyeing machines for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Steam consumption of dyeing machines for textile dyeing	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected
		N_2O	No	Minor Source and thereby neglected
	Electricity consumption for pumping up water that used	CO_2	Yes	Major Source of emissions
		CH_4	No	Minor Source and thereby neglected

	in dyeing processes for textile dyeing	N_2O	No	Minor Source and thereby neglected

As per the methodology AMS-II.D, the source and GHGs considered in the CPA is given in the table below.

D.4. Description of the baseline scenario

As per the methodology AMS II.D./version 12, the baseline scenario for the CPA is demonstrated as follows.

In the absence of the CDM project activity, the Grameen Knitwear would continue to apply the current conventional dyeing practices to consume energy at historical average levels, until the time at which the dyeing practices would be likely to be replaced by the energy and water saving technologies in the absence of the CDM project activity.

The current dyeing practices in the factory are reactive dyes for cellulose (mainly cottons), disperse dyes for CVC and Polyesters regardless of fabric colors. The water and energy consumption for the current dyeing practices in the case of Sclavos machines with 1000 kg capacity is given as follows.

Machine: Sclavos
Unit: kWh/batch
Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	238	238	257
CVC	273	280	316
Polyester	89	99	119

Machine: Sclavos
Unit: Liter/batch
Load capacity: 95%

$WC_{i,j,k,l}^{BL,Batch}$	**Light**	**Medium**	**Dark**
Cellulose	87,200	94,400	105,200
CVC	105,600	105,600	123,600
Polyester	40,400	40,400	51,200

Machine: Sclavos
Unit: kg-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	5,797	6,348	6,969
CVC	6,570	65,70	7,672
Polyester	2,902	2,930	3,592

The fabric load of dyeing machines are various and generally in most factory the fabric load ranges 80%~95%. Then, water and energy consumption respectively for 80%, 85%, 90% and 95% fabric loads are used for baseline water and energy consumption. For conservativeness, as per monitoring data, the value of 80% is used for the case of 80%~85%, the value of 85% for the case of 85%~90%, the value of 90% for the case of 90%~95%, the value of 95% for the case of higher than 95%.

D.5. Demonstration of eligibility for a CPA

No	**Eligibility Criteria**	**Conformity Yes or No**
1	The CPA targets a textile and garment factory in Bangladesh	Yes
2	The name and the address of the factory are defined	Yes
3	The CPA is a new project which is not registered large scale CDM or SSC-CPA in the other PoA	Yes, please refer to A.12 in above
4	There is unique identification of the target factory	Yes
5	Is it possible to submit specification of technology/measure when the DOE validates or verify?	Yes
5	The start date of a CPA is not, or will not be, prior to the commencement of validation of the PoA.	Yes, the starting date of the CPA is after the commencement of the validation of the PoA, 20 November 2012.
7	Does the CPA meet the applicability and other requirements of AMS-II.D as described in PoA-DD	Yes, please refer to D.2 in the above
8	The achieved energy saving of the CPA at a scale of no more than 60 GWh_{th} per year	Yes, for every year during the crediting period, the aggregate energy savings of the CPA will not exceed 60 GWh_{th} per year. The achieved total energy saving from the CPA is estimated to be up to 15 GWh_{th} per year among which 3 GWh_{th} is from electricity saving and other 12 GWh_{th} is from steam saving.
9	If the above condition is not satisfied, a barrier due to prevailing practice in Bangladesh Textile and Garment industry said reactive dyes for cellulose; disperse dyes for CVC and polyester would prevent occurrence of CPAs.	N/A
10	A CPA performs local stakeholder consultation before the inclusion of SSC-CPA.	Yes, the local stakeholder consultation at PoA level was held on 5 November 2012
11	A CPA does not need to performs the environmental impacts analysis according to the regulation of Bangladesh	Yes
12	The CPA does not use any fund from Annex I parties	Yes
13	If the CPA uses a fund from Annex I parties then it does not result in a diversion of official development assistance	N/A

14	The CPA-DD applies 95/10 (confidence /precision) for any necessary survey according	Yes
15	The aggregate energy savings by a CPA does not exceed the equivalent of 180 GWh_{th} per year	Yes,
16	Is a CPA confirmed to a single project, which is not a de-bundled component of another large-scale CPA or CDM project activity as per the latest guidance given in CDM EB?	Yes
17	Is the crediting period of the CPA is within the crediting period of the PoA?	Yes, as the CPA has 10 years crediting period and it is the first CPA of the PoA, so it is hardly said that the crediting period of the CPA exceeds the crediting period of the PoA

As the CPA satisfied all eligibility criteria given in the PoA-DD, then the CPA is eligible for the PoA.

D.6. Estimation of emission reductions

D.6.1. Explanation of methodological choices

Baseline Emissions

As mentioned before, the baseline scenario for the project is the continuation of current dyeing process (mainly conventional reactive dyeing) in the factory.

According to the methodology ASM-II-D, the baseline emission can be calculated based on the following equation.

$$BE_y = (EC^{BL}_{Dyeing,y} + EC^{BL}_{Water,y}) \times EF^{BL,elec}_{CO2} + SC^{BL}_y \times EF^{BL,steam}_{CO2} \qquad (1)$$

Where:

BE_y	Baseline emissions in a year *y* (CO_2 ton/year)
$EC^{BL}_{Dyeing,y}$	Baseline electricity consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year *y* (kWh/year)
$EC^{BL}_{Water,y}$	Baseline electricity consumption by pumping of fresh water that used in dyeing machines in year *y* (kWh/year)
SC^{BL}_y	Baseline steam consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year *y* (ton-steam/year)
$EF^{BL,elec}_{CO2}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EF^{BL,steam}_{CO2}$	CO_2 emission factor for the steam generation for the factory (ton CO_2/ton)

$$EC^{BL}_{Dyeing,y} = \sum_i \sum_j \sum_k \sum_l EC^{BL,Batch,dyeing}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \qquad (2)$$

Where:

$EC^{BL}_{Dyeing,y}$	Baseline electricity consumption by dyeing processes in year *y* (kWh/year)
$EC^{BL,Batch,dyeing}_{i,j,k,l}$	Historical average electricity consumption of a dyeing machine *i* for a batch in the baseline dyeing process for brightness of colour *j* material *k* at a load-type of *l* (kWh/batch)
$NB^{PJ}_{i,j,k,l,y}$	Number of batches on a dyeing machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year *y*
i	Types of dyeing machines in the factory (different maker and different capacity)
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EC^{BL}_{Water,y} = \sum_i \sum_j \sum_k \sum_l WC^{BL,Batch}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \times EC^{BL,pumping}_{clean,water} \qquad (3)$$

Where:

$EF^{BL}_{Water,y}$	Baseline electricity consumption by pumping of water that used in dyeing machines in year *y* (kWh/year)
$WC^{BL,Batch}_{i,j,k,l}$	Historical average water consumption in machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* (Litre/batch)
$NB^{PJ}_{i,j,k,l,y}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
$EC^{BL,pumping}_{clean,water}$	Historical average electricity consumption for pumping groundwater (kWh/liter)
i	Type of dyeing machines in the factory
j	Color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Different load for dyeing a machine in the factory

$$SC^{BL}_y = \sum_i \sum_j \sum_k \sum_l SC^{BL,Batch}_{i,j,k,l} \times NB^{PJ}_{i,j,k,l,y} \qquad (4)$$

Where:

SC^{BL}_y	Baseline steam consumption by dyeing processes in year *y* (ton/year)
$SC^{BL,Batch}_{i,j,k,l}$	Historical average steam consumption of a dyeing machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load-type of *l* (ton-steam/batch)
$NB^{PJ}_{i,j,k,l,y}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load-type of *l* in a year *y*

i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EF_{CO2}^{BL,elec} = \frac{FC_{gen}^{BL,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{BL,fuel}} \quad (5)$$

Where:

$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EG_{gen}^{BL,fuel}$	Historical average of electricity generated from generators (kWh/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{gen}^{BL.fuel}$	Historical fuel consumption average of generators (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)
$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{BL,steam} = \frac{FC_{boiler}^{BL,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{BL,fuel}} \quad (6)$$

Where:

$EF_{CO2}^{BL,steam}$	CO_2 emission factor for the steam generation (ton CO_2/ton steam)
$SP_{steam}^{BL,fuel}$	Historical amount of steam produced from boilers (ton-steam/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
$FC_{steam}^{BL,fuel}$	Historical fuel consumption of boilers (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)
$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

Project Emissions

$$PE_y = (EC_{Dyeing,y}^{PJ} + EC_{Water,y}^{PJ}) \times EF_{CO2}^{PJ,elec} + SC_y^{PJ} \times EF_{CO2}^{PJ,steam} \quad (7)$$

Where:

PE_y	Project emission in a year y (CO_2 ton/year)
$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (kWh/year)
$EC_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in the factory in year y (kWh/year)
SC_y^{PJ}	Project steam consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (ton-steam /year)
$EF_{CO2}^{PJ,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
EF_{CO2}^{steam}	CO_2 emission factor for the steam generation for the factory (ton CO_2/ton)

$$EC_{Dyeing,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{PJ,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} \quad (8)$$

Where:

$EC_{Dyeing,y}^{PJ}$	Project electricity consumption by dyeing processes in year *y* (kWh/year)
$EC_{i,j,k,l}^{PJ,Batch,dyeing}$	Electricity consumption of a machine *i* for a batch in the project dyeing process for brightness of colour *j* material *k* at a load-type of *l* (kWh/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year y
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing machine in the factory

$$EF_{Water,y}^{PJ} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{fresh,water}^{PJ,pumping} \quad (9)$$

Where:

$EF_{Water,y}^{PJ}$	Project electricity consumption by pumping of water that used in dyeing machines in year y (kWh/year)
$WC_{i,j,k,l}^{PJ,Batch}$	Water consumption in machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* (Litre/batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for color *j* material *k* at a load of *l* in a year y
$EC_{fresh,water}^{PJ,pumping}$	Average electricity consumption for pumping underground water in the project in year y (kWh/liter)
i	Type of dyeing machines in the factory
j	Color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Different load for dyeing a machine in the factory

$$SC_y^{PJ} = \sum_i \sum_j \sum_k \sum_l SC_{i,j,k,l}^{PJ,Batch} \times NB_{i,j,k,l,y}^{PJ} \tag{10}$$

Where:

SC_y^{BL}	Project steam consumption by dyeing processes in year *y* (ton-steam /year)
$SC_{i,j,k,l}^{BL,Batch}$	Steam consumption of a machine *i* for a batch in the baseline dyeing process for brightness of colour *j,* material *k* at a load-type of *l* (ton-steam /batch)
$NB_{i,j,k,l,y}^{PJ}$	Number of batches on a machine *i* in the project dyeing for brightness of color *j* material *k* at a load-type of *l* in a year *y*
i	Type of dyeing machines in the factory
j	Brightness of color of textile being dyed in the factory (*j*: light, medium, dark)
k	Type of textile being dyeing in the factory (*k*: cellulose, CVC and polyester)
l	Type of load for dyeing a machine in the factory

$$EF_{CO2}^{PJ,elec} = \frac{FC_{gen}^{PJ,fuel} \times De_{gen}^{fuel} \times NCV_{gen}^{fuel} \times EF_{CO2}^{fuel,gen}}{EG_{gen}^{PJ,fuel}} \tag{11}$$

Where:

$EF_{CO2}^{PJ,elec}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EG_{gen}^{PJ,fuel}$	Amount of electricity generated from generators (kWh/year) in year y.
$FC_{gen}^{PJ.fuel}$	Amount fuel consumption of generators (m^3/year) in a year y.
NCV_{gen}^{fuel}	Net caloric value of the fuel used for generators (TJ/Gg)
De_{gen}^{fuel}	Density of the fuel for generators (kg/m^3)
$EF_{CO2}^{fuel,gen}$	CO_2 emission factor of the fuel for generators (kg-ton CO_2/TJ)

$$EF_{CO2}^{PJ,steam} = \frac{FC_{boiler}^{PJ,fuel} \times De_{boiler}^{fuel} \times NCV_{boiler}^{fuel} \times EF_{CO2}^{fuel,boiler}}{SP_{boiler}^{PJ,fuel}} \tag{12}$$

Where:

$EF_{CO2}^{PJ,steam}$	CO_2 emission factor for the steam generation for the factory (ton CO_2/ton steam)
$SP_{steam}^{PJ,fuel}$	Amount of steam produced from boilers (ton-steam/year) in a year y.
$FC_{steam}^{PJ,fuel}$	Amount of fuel consumption of boilers (m^3/year) in a year y.
NCV_{steam}^{fuel}	Net caloric value of the fuel used for boilers (TJ/Gg)
De_{steam}^{fuel}	Density of the fuel for boilers (kg/m^3)

$EF_{CO2}^{fuel,boiler}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

Leakage

There are no leakage emissions identified for this type of project.
Therefore:

$$L = 0 \tag{13}$$

Emission Reduction

$$ER_y = BE_y - PE_y \tag{14}$$

Where:

ER_y	Emission reduction in year y (ton/year)
BE_y	Baseline emission in a year y (CO_2 ton/year)
PE_y	Project emission in a year y (CO_2 ton/year)

D.6.2. Data and parameters that are to be reported ex-ante

Data / Parameter	$EC_{i,j,k,l}^{BL,Batch,dyeing}$
Unit	kWh/batch
Description	Historical average electricity consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* at the factory
Source of data	Project implementer
Value(s) applied	Please refer to Appendix 4
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$WC_{i,j,k,l}^{BL,Batch}$
Unit	Litre/batch
Description	Historical average water consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l* at the factory
Source of data	Project implementer
Value(s) applied	Please refer to Appendix 4
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EC_{fresh,water}^{BL,pumping}$
Unit	kWh/liter
Description	Historical average electricity consumption for pumping underground water
Source of data	Project implementer
Value(s) applied	0.2
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	Data assumed

Data / Parameter	$SC_{i,j,k,l}^{BL,Batch}$
Unit	Ton-steam/batch
Description	Historical average steam consumption of a machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load of *l*
Source of data	Project implementer
Value(s) applied	Please refer to Appendix 4
Choice of data or Measurement methods and procedures	Measured and calculated through baseline measurement campaign
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$FC_{gen}^{BL,fuel}$
Unit	m^3/year
Description	Historical average amount of natural gas consumption of generators for electricity generation.
Source of data	Project participants
Value(s) applied	72,000
Choice of data or Measurement methods and procedures	Collecting from United Power generation and Distribution that supplies power to the factory. Data for the past three years is preferable; at least one-year vintage data is necessary.
Purpose of data	Used to calculate the baseline emissions
Additional comment	Data for 8 hours in 2012

Data / Parameter	$EG_{gen}^{BL,fuel}$
Unit	kWh/year
Description	Historical average of electricity generated from generators (kWh/year).
Source of data	Project participants
Value(s) applied	280,000
Choice of data or Measurement methods and procedures	Collecting from United Power generation and Distribution that supplies power to the factory. Data for the past three years is preferable; at least one-year vintage data is necessary.
Purpose of data	Used to calculate the baseline emissions
Additional comment	Data for 8 hours in 2012

Data / Parameter	NCV_{gen}^{fuel}
Unit	TJ/Gg
Description	Net caloric value of natural gas used for generators
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	46.5
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	De_{gen}^{fuel}
Unit	kg/m^3
Description	Density of natural gas used for generators
Source of data	FINAL REPORT ON EMISSION INVENTORY, BANGLADESH COUNTRY STUDY, ASIA LEAST-COST GREENHOUSE GAS ABATEMENT STRATEGY (ALGAS)
Value(s) applied	0.72
Choice of data or Measurement methods and procedures	The value used for Bangladesh case
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$EF_{CO2}^{fuel,gen}$
Unit	kg-CO_2/TJ
Description	CO_2 emission factor of natural gas for generators
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	56,100
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Used to calculate the baseline emissions
Additional comment	-

Data / Parameter	$SP_{steam}^{BL,fuel}$
Unit	Ton-steam/year
Description	Historical amount of steam produced from boilers.
Source of data	Project implementer
Value(s) applied	15,000
Choice of data or Measurement methods and procedures	Calculated based on the data collected at the factory. Data for the past three years is preferable; at least one year vintage data is necessary
Purpose of data	Used to calculate the baseline emissions
Additional comment	Assumed data for 2011

Data / Parameter	$FC_{steam}^{BL,fuel}$
Unit	m^3/year
Description	Historical fuel consumption of boilers.
Source of data	Project implementer
Value(s) applied	3,275,639
Choice of data or Measurement methods and procedures	Calculated based on the data collected at the factory. Data for the past three years is preferable; at least one year vintage data is necessary
Purpose of data	Used to calculate the baseline emissions
Additional comment	Actual data for 2011

D.6.3. Ex-ante calculation of emission reductions

For ex-ante calculation of emission reduction from the CPA, the following assumptions are considered with the data in hand at the moment.

- Number of batches 5,000 in 2013.
- One type of dyeing machine (Athena with 100 Kg capacity)
- 95% fabric load
- Among the batches 70% fro cotton (80% dark, 10% medium and 10% light colour), 10% for CVC (80% dark, 10% medium and 10% light colour) 20% for polyester (80% dark, 10% medium and 10% light colour).

Baseline Emissions

As mentioned before, the baseline scenario for the project is the continuation of current dyeing process (Mainly conventional reactive dyeing) in the factory.

The baseline emission can be calculated based on the following equation.

$$BE_y = (EC_{Dyeing,y}^{BL} + EC_{Water,y}^{BL}) \times EF_{CO2}^{BL,elec} + SC_y^{BL} \times EF_{CO2}^{BL,steam} \qquad (1)$$

Where:

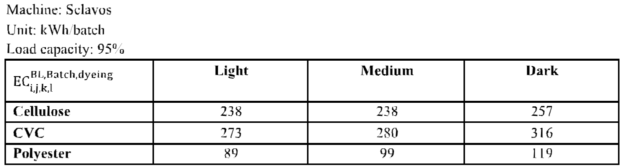
BE_y	Baseline emissions in a year y (CO_2 ton/year)
$EC_{Dyeing,y}^{BL}$	Baseline electricity consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year y (1,154,250 kWh/year)
$EC_{Water,y}^{BL}$	Baseline electricity consumption by pumping of fresh water that used in dyeing machines in year y (202,834 kWh/year).
SC_y^{BL}	Baseline steam consumption by dyeing machines to which the water and energy saving technologies will be introduced by the CPA in year y (30,947 ton-steam/year)
$EF_{CO2}^{BL,elec}$	CO_2 emission factor of electricity generation for the factory (0.449 ton CO_2/MWh)

$EF_{CO2}^{BL,steam}$	CO_2 emission factor for the steam generation for the factory (0.382 ton CO_2/ton-steam)

BE_y = (1,154,250 + 202,834)/1000*0.483 + 30,947* 0.41 = 13,344 ton CO_2/year

$$EC_{Dyeing,y}^{BL} = \sum_i \sum_j \sum_k \sum_l EC_{i,j,k,l}^{BL,Batch,dyeing} \times NB_{i,j,k,l,y}^{PJ} \qquad (2)$$

Where:

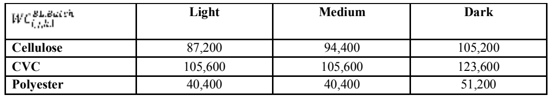
<table>
<tr><td>$EC_{Dyeing,y}^{BL}$</td><td>Baseline electricity consumption by dyeing processes in year <i>y</i> (kWh/year)</td></tr>
<tr><td>$EC_{i,j,k,l}^{BL,Batch,dyeing}$</td><td>Historical average electricity consumption of a dyeing machine <i>i</i> for a batch in the baseline dyeing process for brightness of colour <i>j</i> material <i>k</i> at a load-type of <i>l</i> (kWh/batch).

Machine: Sclavos
Unit: kWh/batch
Load capacity: 95%
<table>
<tr><th>$EC_{i,j,k,l}^{BL,Batch,dyeing}$</th><th>Light</th><th>Medium</th><th>Dark</th></tr>
<tr><td>Cellulose</td><td>238</td><td>238</td><td>257</td></tr>
<tr><td>CVC</td><td>273</td><td>280</td><td>316</td></tr>
<tr><td>Polyester</td><td>89</td><td>99</td><td>119</td></tr>
</table></td></tr>
<tr><td>$NB_{i,j,k,l,y}^{PJ}$</td><td>Numbers of batches on a dyeing machine <i>i</i> in the project dyeing process for brightness of color <i>j</i> material <i>k</i> at a load <i>l</i> in a year y.
For per machine 700 batches for cotton (560 batches for dark, 70 batches for medium and light respectively), 100 batches for CVC (80 batches for dark, 10 batches for medium and light respectively) and 200 batches for polyester (160 batches for dark, 20 batched for medium and light respectively).</td></tr>
<tr><td>i</td><td>Types of dyeing machines in the factory.
5 Sclavos machines with 1000 kg capacity</td></tr>
<tr><td>j</td><td>Brightness of color of textile being dyed in the factory (<i>j</i>: light, medium, dark)</td></tr>
<tr><td>k</td><td>Type of textile being dyeing in the factory (<i>k</i>: cellulose, CVC and polyester)</td></tr>
<tr><td>l</td><td>Type of load for dyeing machine in the factory (95% for all machines)</td></tr>
</table>

$EC_{Dyeing,y}^{BL}$= [(257*560+238*70+238*70)+(316*80+280*10+273*10)+(119*160+99*20+89*20)]*5

= 1,154,250 kWh/year

$$EC_{Water,y}^{BL} = \sum_i \sum_j \sum_k \sum_l WC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \times EC_{clean,water}^{BL,pumping} \qquad (3)$$

Where:

<table>
<tr><td>$EF_{Water,y}^{BL}$</td><td>Baseline electricity consumption by pumping of water that used in dyeing machines in year <i>y</i> (kWh/year)</td></tr>
<tr><td>$WC_{i,j,k,l}^{BL,Batch}$</td><td>Historical average water consumption in machine <i>i</i> for a batch in the baseline dyeing process for colour <i>j</i> material <i>k</i> at a load of <i>l</i> (Litre/batch)

<table>
<tr><th>$WC_{i,j,k,l}^{BL,Batch}$</th><th>Light</th><th>Medium</th><th>Dark</th></tr>
<tr><td>Cellulose</td><td>87,200</td><td>94,400</td><td>105,200</td></tr>
<tr><td>CVC</td><td>105,600</td><td>105,600</td><td>123,600</td></tr>
<tr><td>Polyester</td><td>40,400</td><td>40,400</td><td>51,200</td></tr>
</table></td></tr>
<tr><td>$NB_{i,j,k,l,y}^{PJ}$</td><td>Number of batches on a machine <i>i</i> in the project dyeing for color <i>j</i> material <i>k</i> at a load of <i>l</i> in a year y.
For per machine 700 batches for cotton (560 batches for dark, 70 batches for medium and light respectively), 100 batches for CVC (80 batches for dark, 10 batches for medium and light respectively) and 200 batches for polyester (160 batches for dark, 20 batched for medium and light respectively).</td></tr>
<tr><td>$EC_{freash,water}^{BL,pumping}$</td><td>Historical average electricity consumption for pumping underground water (kWh/liter).
Assume 0.2 kWh/m^3 at the water supply system of the DEPZ.</td></tr>
<tr><td>i</td><td>Type of dyeing machines in the factory (5 Sclavos machines with 1000 kg capacity)</td></tr>
<tr><td>j</td><td>Color of textile being dyed in the factory (<i>j</i>: light, medium, dark)</td></tr>
<tr><td>k</td><td>Type of textile being dyeing in the factory (<i>k</i>: cellulose, CVC and polyester)</td></tr>
<tr><td>l</td><td>Different load for dyeing a machine in the factory (95% for all machines)</td></tr>
</table>

$EF_{Water,y}^{BL}$= [(105.200*560+94.400*70*87.200*70)+(123.600*80+105.600*10+105.600*10)+
(51.200*160+40.400+20+40.400*20)]*5*0.2
= 202,834 kWh/year

$$SC_y^{BL} = \sum_i \sum_j \sum_k \sum_l SC_{i,j,k,l}^{BL,Batch} \times NB_{i,j,k,l,y}^{PJ} \qquad (4)$$

Where:

SC_y^{BL}	Baseline steam consumption by dyeing processes in year *y* (ton/year)
$SC_{i,j,k,l}^{BL,Batch}$	Historical average steam consumption of a dyeing machine *i* for a batch in the baseline dyeing process for colour *j* material *k* at a load-type of *l* (ton-steam/batch)

<table>
<tr><td></td><td>Machine: Sclavos
Unit: kg-steam/batch
Load capacity: 95%<table><tr><th>SP^{fuel}_{steam}</th><th>Light</th><th>Medium</th><th>Dark</th></tr><tr><td>Cellulose</td><td>5,797</td><td>6,348</td><td>6,969</td></tr><tr><td>CVC</td><td>6,570</td><td>65,70</td><td>7,672</td></tr><tr><td>Polyester</td><td>2,902</td><td>2,930</td><td>3,592</td></tr></table></td></tr>
<tr><td>$NB^{PJ}_{i,j,k,l,y}$</td><td>Number of batches on a machine <i>i</i> in the project dyeing for color <i>j</i> material <i>k</i> at a load-type of <i>l</i> in a year <i>y</i>.
For per machine 700 batches for cotton (560 batches for dark, 70 batches for medium and light respectively), 100 batches for CVC (80 batches for dark, 10 batches for medium and light respectively) and 200 batches for polyester (160 batches for dark, 20 batched for medium and light respectively).</td></tr>
<tr><td><i>i</i></td><td>Type of dyeing machines in the factory (5 Sclavos machines with 1000 kg capacity)</td></tr>
<tr><td><i>j</i></td><td>Brightness of color of textile being dyed in the factory (<i>j</i>: light, medium, dark)</td></tr>
<tr><td><i>k</i></td><td>Type of textile being dyeing in the factory (<i>k</i>: cellulose, CVC and polyester)</td></tr>
<tr><td><i>l</i></td><td>Type of load for dyeing machine in the factory (95% for all machines)</td></tr>
</table>

SC^{BL}_{y}= [(6,969*560+6,348*70+5,797*70)+(7,672*80+6,570*10+6,570*10
+(3,592*160+2,930*20+2,902*20)]/1,000*5
=30,947 ton-steam/year

$$EF^{BL,elec}_{CO2} = \frac{FC^{BL,fuel}_{gen} \times De^{fuel}_{gen} \times NCV^{fuel}_{gen} \times EF^{fuel,gen}_{CO2}}{EG^{BL,fuel}_{gen}} \qquad (5)$$

Where:

$EF^{BL,elec}_{CO2}$	CO_2 emission factor of electricity generation for the factory (ton CO_2/MWh)
$EG^{BL,fuel}_{gen}$	Historical average of electricity generated from generators (kWh/year). Data for the past three years is preferable; at least one-year vintage data is necessary. 280,000 kWh/8 hours (United Power generation and Distribution)
$FC^{BL.fuel}_{gen}$	Historical natural gas consumption average of generators (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary. 72,000 m^3/8 hours (United Power generation and Distribution)
NCV^{fuel}_{gen}	Net caloric value of the natural gas used for generators (T46.5 J/Gg). IPCC default value
De^{fuel}_{gen}	Density of the fuel for generators (0.72 kg/m^3). IPCC default value
$EF^{fuel,gen}_{CO2}$	CO_2 emission factor of the natural gas for generators (56,100 kg-ton CO_2/TJ) IPCC default value

$EF^{BL,elec}_{CO2}$= 0.483 ton CO_2/MWh

$$EF^{BL,steam}_{CO2} = \frac{FC^{BL,fuel}_{boiler} \times De^{fuel}_{boiler} \times NCV^{fuel}_{boiler} \times EF^{fuel,boiler}_{CO2}}{SP^{BL,fuel}_{boiler}} \qquad (6)$$

Where:

$EF^{BL,steam}_{CO2}$	CO_2 emission factor for the steam generation (ton CO_2/ton steam)
$SP^{BL,fuel}_{steam}$	Historical amount of steam produced from boilers (ton-steam/year). Data for the past three years is preferable; at least one-year vintage data is necessary. Assume 15,000 ton-steam for 2011
$FC^{BL,fuel}_{steam}$	Historical natural gas consumption of boilers (m^3/year). Data for the past three years is preferable; at least one-year vintage data is necessary. 3,275,639 m^3 for 2011
NCV^{fuel}_{steam}	Net caloric value of the fuel used for boilers (TJ/Gg)
De^{fuel}_{steam}	Density of the fuel for boilers (kg/m^3)
$EF^{fuel,boiler}_{CO2}$	CO_2 emission factor of the fuel for boilers (kg-ton CO_2/TJ)

$EF^{BL,steam}_{CO2}$= 0.41 ton CO_2/ton-steam

Project Emissions

$$PE_y = (EC^{PJ}_{Dyeing,y} + EC^{PJ}_{Water,y}) \times EF^{PJ,elec}_{CO2} + SC^{PJ}_{y} \times EF^{PJ,steam}_{CO2} \qquad (7)$$

Where:

PE_y	Project emission in a year y (CO_2 ton/year)
$EC^{PJ}_{Dyeing,y}$	Project emission from electricity consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (kWh/year).
$EF^{PJ}_{Water,y}$	Project emission from electricity consumption by pumping of water that used in dyeing machines in the factory in year y (kWh/year)
SC^{PJ}_{y}	Project emission from steam consumption by dyeing machines to which water and energy saving technologies introduced by the CPA in year *y* (ton-steam /year)
$EF^{PJ,elec}_{CO2}$	CO_2 emission factor of electricity generation for the factory (Assume 0.449 ton CO_2/MWh)
EF^{steam}_{CO2}	CO_2 emission factor for the steam generation for the factory (Assume 0.382 ton CO_2/ton-steam)

As the project is seen to cut electricity consumption by 75% and steam consumption by 50%, the project CO_2 emission can be estimates as follows.

PE_y = (1,154,250 + 202,834)/1000*0.483*0.25 + 30,947* 0.41*0.5
= 6,508 ton CO_2/year

Leakage

There are no leakage emissions identified for this type of project.
Therefore:

$$L = 0 \tag{13}$$

Emission Reduction

$$ER_y = BE_y - PE_y \tag{14}$$

Where:

ER_y	Emission reduction in year y (ton/year)
BE_y	Baseline emission in a year y (13,344 CO_2 ton/year)
PE_y	Project emission in a year y (6,508CO_2 ton/year)

ER_y = 13,344 – 6,508 = 6,836 Ton/year

D.6.4. Summary of the ex-ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
1/6/2013	13,344	6,508	0	6,836
1/6/2014	13,344	6,508	0	6,836
1/6/2015	13,344	6,508	0	6,836
1/6/2016	13,344	6,508	0	6,836
1/6/2017	13,344	6,508	0	6,836
1/6/2018	13,344	6,508	0	6,836
1/6/2019	13,344	6,508	0	6,836
1/6/2020	13,344	6,508	0	6,836
1/6/2021	13,344	6,508	0	6,836
1/6/2022	13,344	6,508	0	6,836
Total	133,440	65,080	0	68,360
Total number of crediting years	10 years			
Annual average over the crediting period	13,344	6,508	0	6,836

D.7. Application of the monitoring methodology and description of the monitoring plan

D.7.1. Data and parameters to be monitored

The following data should be monitored.

<table>
<tr><td>Data / Parameter</td><td>$NB_{i,j,k,l,y}^{PJ}$</td></tr>
<tr><td>Unit</td><td>Number</td></tr>
<tr><td>Description</td><td>Number of batches on a machine <i>i</i> in the project dyeing for color <i>j</i> material <i>k</i> at a load of <i>l</i> in a year y</td></tr>
<tr><td>Source of data</td><td>Project implementer</td></tr>
<tr><td>Value(s) applied</td><td>Machine: Sclavos
Unit: Batch/machine
Load capacity: 95%
<table>
<tr><td>Number of Batches</td><td>Light</td><td>Medium</td><td>Dark</td></tr>
<tr><td>Cellulose</td><td>70</td><td>70</td><td>560</td></tr>
<tr><td>CVC</td><td>10</td><td>10</td><td>80</td></tr>
<tr><td>Polyester</td><td>20</td><td>20</td><td>160</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Aggregation of daily records in the factory.</td></tr>
<tr><td>Monitoring frequency</td><td>Project implementer aggregate the daily-recorded data monthly</td></tr>
<tr><td>QA/QC procedures</td><td>It is mandatory for dyeing maters to record every batch in each machine in terms of fabric load, fabric type and fabric colour.</td></tr>
<tr><td>Purpose of data</td><td>For calculating project energy and water consumption</td></tr>
<tr><td>Additional comments</td><td>Estimated values</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$EC_{i,j,k,l}^{PJ,Batch,dyeing}$</td></tr>
<tr><td>Unit</td><td>kWh/batch</td></tr>
<tr><td>Description</td><td>Electricity consumption of a machine <i>i</i> for a batch in the project dyeing process for color <i>j</i> material <i>k</i> at a load of <i>l</i> in a year y</td></tr>
<tr><td>Source of data</td><td>Project implementer</td></tr>
<tr><td>Value(s) applied</td><td>Machine: Sclavos
Unit: kWh/batch
Load capacity: 95%
<table>
<tr><th>$EC_{i,j,k,l}^{PJ,Batch,dyeing}$</th><th>Light</th><th>Medium</th><th>Dark</th></tr>
<tr><td>Cellulose</td><td>59</td><td>59</td><td>64</td></tr>
<tr><td>CVC</td><td>68</td><td>70</td><td>79</td></tr>
<tr><td>Polyester</td><td>22</td><td>24</td><td>29</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Measuring through electric meters installed at points of power lines to each dyeing machine at the factory. Dyeing masters read and record electricity consumption from electric meters for each batch and the CME aggregates the data monthly from the factory where the data recorded for each batch by dyeing masters.</td></tr>
<tr><td>Monitoring frequency</td><td>For each batch.</td></tr>
<tr><td>QA/QC procedures</td><td>Calibrations of electric power meters will be conducted as per related national regulations and international standards.</td></tr>
<tr><td>Purpose of data</td><td>For calculating project emission from electricity consumption</td></tr>
<tr><td>Additional comments</td><td>The values given above are estimated values</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$WC_{i,j,k,l}^{PJ,Batch}$</td></tr>
<tr><td>Unit</td><td>Litre/batch</td></tr>
<tr><td>Description</td><td>Water consumption of a machine <i>i</i> for a batch in the project dyeing process for colour <i>j</i> material <i>k</i> at a load of <i>l</i></td></tr>
<tr><td>Source of data</td><td>Project implementer</td></tr>
<tr><td>Value(s) applied</td><td>Machine: Sclavos
Unit: Liter/batch
Load capacity: 95%
<table>
<tr><th>$WC_{i,j,k,l}^{PJ,Batch}$</th><th>Light</th><th>Medium</th><th>Dark</th></tr>
<tr><td>Cellulose</td><td>43,600</td><td>47,200</td><td>52,600</td></tr>
<tr><td>CVC</td><td>52,800</td><td>52,800</td><td>61,800</td></tr>
<tr><td>Polyester</td><td>20,200</td><td>20,200</td><td>26,600</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Measuring and calculating based on water tanks of the machines, bath ratios and performed dyeing charts.
The CME aggregates the data monthly from the factory where the data recorded for each batch by dyeing masters.</td></tr>
<tr><td>Monitoring frequency</td><td>For each batch.</td></tr>
<tr><td>QA/QC procedures</td><td>Calculated data based on the performed dyeing charts of machines is believed to be a conservative value.</td></tr>
<tr><td>Purpose of data</td><td>For calculating project emission from water consumption</td></tr>
<tr><td>Additional comments</td><td>The values given above are estimated values</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$SC_{i,j,k,l}^{PJ,Batch}$</td></tr>
<tr><td>Unit</td><td>To-steam/batch</td></tr>
<tr><td>Description</td><td>Steam consumption of a machine <i>i</i> for a batch in the project dyeing process for colour <i>j</i> material <i>k</i> at a load of <i>l</i> (ton-steam /batch)</td></tr>
<tr><td>Source of data</td><td>Project implementer</td></tr>
<tr><td>Value(s) applied</td><td>Machine: Sclavos
Unit: kg-steam/batch
Load capacity: 95%
<table>
<tr><td>$SC_{i,j,k,l}^{PJ,Batch}$</td><td>Light</td><td>Medium</td><td>Dark</td></tr>
<tr><td>Cellulose</td><td>2,899</td><td>3,174</td><td>3,485</td></tr>
<tr><td>CVC</td><td>3,285</td><td>3,285</td><td>3,836</td></tr>
<tr><td>Polyester</td><td>1,451</td><td>1,465</td><td>1,796</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Measuring through steam meters installed at the points of steam pipes for each dyeing machine. Dyeing masters read and record electricity consumption from electric meters for each batch and the CME aggregates the data monthly from the factory where the data recorded for each batch by dyeing masters.</td></tr>
<tr><td>Monitoring frequency</td><td>For each batch.</td></tr>
<tr><td>QA/QC procedures</td><td>Crosschecking with a calculated data based on the performed dyeing charts of machines in the factory.
Steam meters will be calibrated as per related national regulations and international standards</td></tr>
<tr><td>Purpose of data</td><td>For calculating project emission from steam consumption</td></tr>
<tr><td>Additional comments</td><td>The values given above are estimated values</td></tr>
</table>

Data / Parameter	$EC_{fresh,water}^{PJ,pumping}$
Unit	kWh/litre
Description	Electricity consumption for pumping groundwater in the water supply system
Source of data	Project implementer
Value(s) applied	0.2
Measurement methods and procedures	Calculating based on the collected data from the water supply system of the SEPZ.
Monitoring frequency	Monthly
QA/QC procedures	Official data of the DEPZ
Purpose of data	For calculating project emission from water consumption
Additional comments	The values given above are estimated values

Data / Parameter	$EG_{gen}^{PJ,fuel}$
Unit	MWh/year
Description	Amount of electricity generated from generators in a year y
Source of data	Project implementer
Value(s) applied	306,600
Measurement methods and procedures	Collecting from United Power generation and Distribution
Monitoring frequency	Monthly
QA/QC procedures	Official data from United Power generation and Distribution Company
Purpose of data	For calculating CO_2 emission factor for electricity generation
Additional comments	The values given above are estimated values

Data / Parameter	$FC_{gen}^{PJ.fuel}$
Unit	m^3/year
Description	Amount of fuel consumed by generators for electricity generation in a year y
Source of data	Project implementer
Value(s) applied	78,840,000
Measurement methods and procedures	Collecting from United Power generation and Distribution
Monitoring frequency	Monthly
QA/QC procedures	Official data from power provider the United Power generation and Distribution Company.
Purpose of data	For calculating CO_2 emission factor for electricity generation
Additional comments	The values given above are estimated values

Data / Parameter	$SP_{steam}^{PJ,fuel}$
Unit	Ton-steam/year
Description	Amount of steam produced by boilers in a year y
Source of data	Project implementer
Value(s) applied	15,000
Measurement methods and procedures	Measuring through steam flow meters installed at the points of steam delivery pipes from the boilers.
Monitoring frequency	Monthly
QA/QC procedures	Crosschecking with the data calculated based on the boiler operation data. Steam meters will be calibrated as per related national regulations and international standards
Purpose of data	For calculating CO_2 emission factor for steam generation
Additional comments	The values given above are estimated values

Data / Parameter	$FC_{steam}^{PJ,fuel}$
Unit	m^3/year
Description	Amount of fuel consumed by boilers for steam generation in a year y
Source of data	Project implementer
Value(s) applied	3,275,639
Measurement methods and procedures	Measuring through gas meters that installed at the points of gas pipes for boilers.
Monitoring frequency	Monthly
QA/QC procedures	Crosschecking with gas purchase bills. Gas flow meters will be calibrated as per related national regulations and international standards
Purpose of data	For calculating CO_2 emission factor for steam generation
Additional comments	The values given above are estimated values

D.7.2. Description of the monitoring plan

According to the AMS-II.D (version 12), the energy consumption for industrial process is required to be monitored though meters, the monitoring plan is developed to ensure the monitoring of the energy consumptions and calculating energy savings using the monitored and other necessary data and information through identifying different stakeholders responsibility, stipulating quality assurance systems and emphasizing recording and reporting systems. The monitoring plan is unfolded as follows.

(1) Monitoring Framework

The W.S.T will act as the overall supervisor and prepare a monitoring report periodically (typically annually) to the DOE based on the data and information reported by the project implementer, GK.

The CPA implementer, GK will undertake the monitoring (especially preparing the monthly and annual status report) based on the operation and monitoring manual prepared by W.S.T.
The W.S.T has a responsibility to manage and operate the CPA.

(2) The Function of CME and the CPA Implementer

The following table shows the roles of the CME and the project implementer for the monitoring.

	CME (W.S.T supported by PEAR)	GK
Monitoring management	- Develop the operation and monitoring manual for activities. - Develop and establish data collection and reporting system for parameters monitored in every CPAs. - Implement and manage monitoring of CPAs.	- Implement and manage monitoring of the project activities
Data collection	- Establish and maintain data collection systems for parameters monitored. - Check data quality and collection procedures regularly.	- Implement data collection; especially after the project implementation. - Check internal data quality and collection procedures regularly
Data storage and management	- Develop database format of CPA. - Check the reported data from each CPAs. - Calculate emission reductions based on the data reported by the implementers. - Implement data management of CPAs. - Store and maintain records.	- Enter collected data to a computer database. - Implement data management of the activities. - Store and maintain records. - All of the monitoring parameters under the monitoring plan would be kept for 2 years after the end of the crediting period or the last issuance of CERs for this project activity, whichever is later
Communication and reporting	- Analyse data and compare project performances. - Prepare and forward monthly or annual reports.	- Monthly report electronic data to the CME
CDM training and capacity building	- Develop and establish training program for implementers - Organize regular internal audit for collected data	- Implement internal training for staffs on the monitoring - Conduct internal audit for all recorded data twice year
Quality assurance and verification	- Develop a monitoring manual includes quality assurance systems such as calibration procedures for various meters and crosschecks with a view to ensuring transparency and allowing for verification. - Prepare for, facilitate and coordinate verification process.	- Undertake regular check internal of data collection - All of information are recorded and reported to CME. - Ensure regular calibration of electric power meters, steam flow meters and other related measures.

(3) Monitored Data

The data to be monitored are described in section D.7.1 above.

(4) Data Collection

Data collection is conducted by both of the W.S.T and the project implementer.
The W.S.T will collect data from the project implementer and check the quality of the data reported.
The project implementer is mainly in charge of data collection from its own factory and from other sources.

SECTION E. Approval and authorization

The applications for Bangladesh and Japanese Government approvals will be conducted during the validation and approval letters from both countries should be obtained before submitting application for registration.

- - - - -

Appendix 1: Contact information on entity/individual responsible for the CPA

Organization	Grameen Knitwear Ltd.
Street/P.O. Box	Mirpur-2
Building	Grameen Bank Complex
City	Dhaka
State/Region	
Postcode	1216
Country	Bangladesh
Telephone	880-2-8054034
Fax	880-2-8050395
E-mail	gknit@grameen.com
Website	www.grameenknitwear.com/
Contact person	Ashraful Hassan
Title	Managing Director
Salutation	Mr.
Last name	Hassan
Middle name	
First name	Ashraful
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	aashraf@grameentelecom.net.bd

Organization	Green Project W.S.T
Street/P.O. Box	Sonargaon Janapath Road
Building	KC Tower
City	Dhaka
State/Region	Uttara
Postcode	1230
Country	Bangladesh
Telephone	880-2-8054034
Fax	880-2-8050395
E-mail	info@greenproject-wst.com
Website	www.greenprojeject-wst.com
Contact person	Wolfram Engel
Title	President and CEO
Salutation	Dr.
Last name	Engel
Middle name	
First name	Wolfram
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	engel.consulting.hk@gmail.com

Organization	PEAR Carbon Offset Initiative, Ltd.
Street/P.O. Box	1-10-11 Tsukuji
Building	1002 RATIO
City	Chuo-ku
State/Region	Tokyo
Postcode	104-0045
Country	Japan
Telephone	+81-3-3248-0557
Fax	+81-3-3248-0557
E-mail	n_matsuo@pear-carbon-offset.org
Website	http://www.pear-carbon-offset.org
Contact person	Naoki Matsuo
Title	CEO
Salutation	Dr.
Last name	Matsuo
Middle name	
First name	Naoki
Department	
Mobile	+81-90-9806-0723
Direct fax	
Direct tel.	
Personal e-mail	n_matsuo@pear-carbon-offset.org

Appendix 2: Affirmation regarding public funding

The CPA does not use any public fund.

Appendix 3: Applicability of the selected methodology (ies)

The applicability of the small-scale methodology, AMS II.D has been detailed in the section D.2.

Appendix 4: Further background information on ex ante calculation of emission reductions

The water and energy (electricity and steam) consumption for baseline are measured and calculated by W.S.T together with Japan Textile Consultant Center (JTCC) through an auditing that was conducted during 8~13 August 2012 toward the GK factory. The electricity consumption for batches are calculated based on the operation powers measured and times of operation while water and steam consumption are calculated as per performed dyeing charts that is judged by experts and machine makers as a very conservative way for baseline water and energy consumption.

The following are the water and energy consumptions for the 5 Sclavos machines in the case of 95% fabric load capacity.

Machine: ATHENA (with 1000 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	238	238	257
CVC	273	280	316
Polyester	89	99	119

Machine: HT-4 (with 720 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC_{i,j,k,l}^{BL,Batch,dyeing}$	**Light**	**Medium**	**Dark**
Cellulose	148	148	160
CVC	170	174	197
Polyester	55	62	74

Machine: HT-3 (with 720 kg capacity)
Unit: kWh/batch

Load capacity: 95%

$EC^{BL,Batch,dyeing}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	141	141	153
CVC	162	166	188
Polyester	53	59	71

Machine: AT-4 (with 540 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC^{BL,Batch,dyeing}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	162	162	175
CVC	185	190	215
Polyester	60	67	81

Machine: HT-1 (with 180 kg capacity)
Unit: kWh/batch
Load capacity: 95%

$EC^{BL,Batch,dyeing}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	81	81	87
CVC	93	95	107
Polyester	30	34	40

Machine: ATHENA (with 1000 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC^{BL,Batch}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	87,200	94,400	105,200
CVC	105,600	105,600	123,600
Polyester	40,400	40,400	51,200

Machine: HT-4 (with 720 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC^{BL,Batch}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	82,944	90,144	100,944
CVC	99,216	93,366	117,216
Polyester	34,416	31,491	45,216

Machine: HT-3 (with 720 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC^{BL,Batch}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	82,944	90,144	100,944
CVC	99,216	93,366	117,216
Polyester	34,416	31,491	45,216

Machine: AT-4 (with 540 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC^{BL,Batch}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	80,208	87,408	98,208
CVC	95,112	95,112	113,112
Polyester	30,312	28,755	41,112

Machine: HT-1 (with 180 kg capacity)
Unit: Liter/batch
Load capacity: 95%

$WC^{BL,Batch}_{i,j,k,l}$	Light	Medium	Dark
Cellulose	74,736	81,936	92,736
CVC	86,904	86,904	104,904
Polyester	22,104	23,283	31,904

Machine: ATHENA (with 1000 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP^{fuel}_{steam}	Light	Medium	Dark
Cellulose	5,797	6,348	6,969
CVC	6,570	65,70	7,672
Polyester	2,902	2,930	3,592

Machine: HT-4 (with 720 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP^{fuel}_{steam}	Light	Medium	Dark
Cellulose	5,359	6,000	6,540
CVC	5,860	5,457	6,962
Polyester	2,280	1,989	2,964

Machine: HT-3 (with 720 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP^{fuel}_{steam}	Light	Medium	Dark
Cellulose	5,359	6,000	6,540
CVC	5,860	5,457	6,962
Polyester	2,280	1,989	2,964

Machine: AT-4 (with 540 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	5,163	5,715	6,328
CVC	5,532	5,532	6,635
Polyester	1,958	1,810	2,638

Machine: HT-1 (with 180 kg capacity)
Unit: ton-steam/batch
Load capacity: 95%

SP_{steam}^{fuel}	**Light**	**Medium**	**Dark**
Cellulose	4,713	5,265	5,861
CVC	4,789	4,789	5,892
Polyester	1,257	1,395	1,930

Appendix 5: Further background information on monitoring plan

Please refer to section D.7 of the document

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History of the document

Version	**Date**	**Nature of revision(s)**
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the component project activity design document form" (EB 66, Annex 16).
01	EB33, Annex42 27 July 2007	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		

平成 24 年度 CDM 実現可能性調査　現地調査報告書

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット・イニシアティブ	調査回数	第　1　回

（※現地調査の結果を、下記項目に沿って、2～3 頁程度で報告してください。）

1.　現地調査出張者（外注先などの随伴者がいる場合、そう分かるように記載）：

第一回現地調査の人員構成は、下記のようである。

PEAR:

松尾　直樹

ウテイクル　ゴジャシ

JTCC（日本繊維技術センター）：

森本　国広

東海　恵治

田畑　収

2.　現地調査日程（出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載）：

月日	訪問先
8月31日	成田→ダッカ市内宿泊
9月1日	資料整理、ダッカ着（松尾）
9月2日	午前：現地カウンターパートナー（WST, Grameen Knitwear 及び Landmark）協議。紡績工場燃料消費量、水消費量測定、診断内容、項目の説明と議論。午後：Landmark 工場視察、データ入手ための測定器械設置ポイントのチェック及び関連事項に関する協議。
9月3日	Landmark 工場において、測定、診断の実施。
9月4日	Landmark 工場において、測定、診断の実施。
9月5日	Landmark 工場において、測定、診断の実施。
9月6日	午前：データ整理。午後：Landmark 工場測定、診断結果の発表。
9月7日	資料整理、
9月8日	資料整理
9月9日	Grameen Knitwear 工場において、測定、診断の実施。
9月10日	Grameen Knitwear 工場において、測定、診断の実施。
9月11日	Grameen Knitwear 工場において、測定、診断の実施。
9月12日	Grameen Knitwear 工場において、測定、診断の実施。
9月13日	午前：データ整理。午後：Grameen Knitwear 工場測定、診断結果の発表。
9月14日	ダッカーバンコクー東京
9月15日	成田着

3.　日程･時間工程別調査内容（現地の訪問先･協議者なども記載）：

月日	業務内容
8 月 31 日(金)	羽田空港ーバンコクーダッカ（ゴジャシ） 関空ーバンコクーダカ（森本、東海、田畑）
9 月 1 日(土)	資料整理（ゴジャシ、森本、東海、田畑） 羽田ーバンコクーダッカ（松尾）
9 月 2 日　(日)	午前：10:30～12:30 訪問先：W.S.T.のオッフィス（ダッカ） 業務内容：Grameen Knitwear, W.S.T. and Landmark との会議。ミッションの説明、関連事項の確認を行った。 参加者： バングラデシュ側：Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Mr. Anwar Hossain (Grameen Knitwear, General Manager) Mr. Mahbubul Islam (Grameen Knitwear, Dyeing Manager) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々（参加者名簿を参考に） 日本側：松尾、ゴジャシ、森本、東海、田畑 午後：14:30～17:30 訪問先：Landmark Factory（ダッカ郊外） 業務内容：測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 3 日（月）	10：30～17：30 訪問先：Landmark Factory（ダッカ郊外） 業務内容：測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam　(W.S.T.)

	日本側：松尾、ゴジャシ、森本、東海、田畑 日本側:松尾、ゴジャシ、森本、東海、田畑
9月4日（火）	10:30～17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月5日（水）	10:30～17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月6日（木）	午前：データ整理 午後：3:00～5:00 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容：Landmark 工場測定、診断結果の発表。 参加者： バングラデシュ側:Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々(参加者名簿を参考に) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月7日（金）	資料整理
9月8日（土）	10:30～17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:補足データ収集・測定

	参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.). 日本側：松尾、ゴジャシ、森本、東海、田畑
9月9日（日）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月11日（月）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月12日（火）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月13日（水）	午前：資料整理 午後：3:00～5:00 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容:Landmark 工場測定、診断結果の発表。 参加者: バングラデシュ側:Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for

	Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Mr. Anwar Hossain (Grameen Knitwear, General Manager) Mr. Mahbubul Islam (Grameen Knitwear, Dyeing Manager) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々（参加者名簿を参考に） 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 14 日（木）	ダッカ～バンコク～成田　（松尾、ゴジャシ） ダッカ～バンコク～関空　（森本、東海、田畑）
9 月 15 日（）	成田着（松尾、ゴジャシ） 関空着（森本、東海、田畑）

4.　調査結果概要

（1）バングラデシュの紡績工場における染色過程の現状の確認ができた。

今回の二つの紡績工場での調査結果から見ると染色機における電力消費量は、染色過程の電力消費量の約３０％、蒸気の消費量は、約９５％であることが判明でき、染色機における染色手法の改善を対象とする本 PoA で技術の省エネ効果に関しての確信ができた。今回の測定・診断の報告書は作成中である。

（2）ベースライン設定及びモニタリングの関連事項の検討と確認ができた。

ベースラインの決定のためのバッチごとのエネルギー（電力、蒸気）消費量の実績の把握可能性についての確認ができ、色 × 材料の組み合わせごとにエネルギー消費量の実績データを収集することになった。

モニタリングが必要となる染色機における電力及び蒸気消費量に関して、現実を踏まえ、電力消費量を直接測定する一方、専門家との検討によって蒸気消費量を、染色機における染色実績のグラフによって計算することにした。

（3）今後の事項に関する確認と合意ができた。

今後の予定事項（利害関係者会議、有効審査）などについて、合意ができた。例えば、１０月での利害関係者会議の開催、１１月での有効審査の開始、１２月での有効審査現地調査などで現地パートナーとの合意ができた。

5.　特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6.　その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）

（1）染色機における染色過程の実績のグラフの収集と管理

（2）グリッド或はキャプティブ発電者の CO2 排出係数の把握

（3）PoA-DD 及び CPA-DDs の作成

平成24年度CDM実現可能性調査　現地調査報告書

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット・イニシアティブ	調査回数	第　2　回

1.　現地調査出張者:

第2回現地調査の人員構成は、下記のようである。

PEAR: ウテイクル　ゴジャシ

2.　現地調査日程（出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載）:

月日	訪問先
11月3日	羽田～バンコク～ダッカ（ダッカ市内宿泊）
11月4日	現地カウンターパートナー（W.S.T, Grameen Knitwear 及び Landmark）協議。利害関係者会議の準備条状況の確認。
11月5日	利害関係者会議
11月6日	会議結果の整理、W.S.T と今後の予定、関連事項及びデータなどについての協議
11月7日	ダッカ～バンコク
11月8日	成田着

3.　日程・時間工程別調査内容（現地の訪問先・協議者なども記載）:

月日	業務内容
11月3日(土)	羽田空港ーバンコクーダッカ
11月4日(日)	午前:10:30～13:30 訪問先:W.S.T.のオッフィス（ダッカ） 業務内容:会議準備状況の確認及び染色機メーカーからの専門家と染色過程における水・蒸気消費量の計算方法について協議。 参加者: バングラデシュ側:Mr. Herman Freericks (Thies) Mr. Thomas Mende (Thies) Mr. Kauser Bhuiyan (W.S.T) Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) 日本側:ゴジャシ 午後:14:30~17:30 訪問先:会議場 業務内容:会議場の確認 参加者: バングラデシュ側:Mr. Arman Islam (W.S.T.) Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) その他の W.S.T 及び Grameen Knitwear と Landmark の代表 日本側:ゴジャシ
11月5日（月）	午前:10:30～13:00 訪問先:Lotus Hall, Uttara Club, Dhaka 業務内容:利害関係者会議へ参加 参加者: バングラデシュ側:Vice president of Bangladesh Garment Manufacturers and Exporters Association (BGMEA) Grameen Knitwear and Landmark の代表 そのたの紡績工場代表者 染色機メーカー代表者 など50名以上 日本側:ゴジャシ
11月6日（火）	10:30～17:30 訪問先:W.S.T.のオッフィス（ダッカ） 業務内容:会議の結果の整備及び今後の予定確認 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam　(W.S.T.) 日本側：ゴジャシ
11月7日（火）	ダッカ～バンコク
11月8日（木）	成田着

4.　調査結果概要

（1）利害関係者会議へ参加

参加者の意見、コメントを収集でき、ドラフト PoA-DD の完成できました。

（2）専門家と染色機における水・蒸気の消費量の計算方法（染色過程グラフに基づいて）に関して議論を行い、意見及び指導を受けることができました。すなわち、現在の計算方法では、問題ないそうですが、専門家からより詳細な計算方法を提供して頂くことになりました。

（3）今後の事項に関する確認と合意ができた。

今後の予定事項（有効審査の現地調査の予定）などについて、合意ができた。例えば、11 月での有効審査の開始、1月のはじめに有効審査現地調査などで現地パートナーとの合意ができました。

また、11月中にバングラデシュの紡績工場での染色方法におけるコモンプラクティスを示すために、質問票形式サーベイ実施することで合意できました。

5. 特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6. その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）

（1） CPA-DDs の作成に必要となるデータ及び情報の入手。

平成 24 年度 CDM 実現可能性調査　現地調査報告書

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット･イニシアティブ	調査回数	第　3　回

1. 現地調査出張者：

第 2 回現地調査の人員構成は、下記のようである。

PEAR: 直樹　松尾
ウテイクル　ゴジャシ
JQA: 暁子　古屋
宏　小林

2. 現地調査日程（出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載）：

月 日	訪問先
1 月 5 日	羽田～バンコク～ダッカ（ダッカ市内宿泊） W.S.T と打ち合わせ。
1 月 6 日	Grameen Knitwear 工場への訪問
1 月 7 日	電力供給会社United Power Generation and Distribution CompanyLtd.と水供給システム（Water Supply System）を視察
1月8日	Japan Textile Products Quality and Technology Center (QTEC) Dhaka Lab を訪問また染色剤、薬品を生産者（Dystar、Clariant (Bangladesh) Ltd）代表と面談。
1 月 9 日	Landmark Factory及びBangladesh GarmentManufacturers & Exporters Association (BGMEA)を訪問
1 月 10 日	午前：Closing meeting 午後：ダッカ～バンコク～成田
1 月 11 日	成田着

3. 日程･時間工程別調査内容（現地の訪問先･協議者なども記載）：

月 日	業務内容
1 月 5 日(土)	羽田空港ーバンコクーダッカ
1 月 6 日(日)	午前：9:00～16:30 訪問先：Grameen Knitwear 工場（ダッカ郊外） 業務内容：CPA1　の対象である工場の事情確認とデータ収集 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.)

	Mr. Suvro Dev Saha (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側：松尾、ゴジャシ、古屋、小林
1月7日（月）	午前：9：00～12:00 訪問先：United Power Generation and Distribution Company Ltd. 業務内容：排出係数のための燃料消費量及び発電量データの確認 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側：松尾、ゴジャシ、古屋、小林 午後：13：00～17：00 訪問先：DEPZ Water Supply System及びDEPZ Central Effluent Treatment System 業務内容：水供給システム（ポンプなど）の運営状況と関連データの確認 参加者： バングラデシュ側：Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側：松尾、ゴジャシ、古屋、小林
1月８日（火）	９：００～１１:30 訪問先：W.S.T.での染色剤、薬品生産者代表の面談 業務内容：各染色過程における染色剤、薬品などに関する情報の確認 参加者： バングラデシュ側：Dystar、Clariant (Bangladesh) Ltd）の代表者 午後：13：00～15：00 訪問先：Japan Textile Products Quality and Technology Center (QTEC) Dhaka La 業務内容：プロジェクトに対して、専門家的な意見の収集。 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) (QTEC)の専門家 日本側：松尾、ゴジャシ、古屋、小林
1月９日（火）	９：００～１１:30 訪問先：Bangladesh Garment Manufacturers & Exporters Association (BGMEA) 業務内容：バングラデシュ紡績業界事情などの確認 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) BGMEA の関連スタッフ 午後：13：00～17：00 訪問先：Landmark Factory 業務内容：今後の CPA の対象となる工場の事情確認 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) 工場関連スタッフ 日本側：松尾、ゴジャシ、古屋、小林
１月１０日（木）	９：００～１１：００ 訪問先：W.S.Tオフィス 業務内容：Closing meeting 午後：ダッカ空港 ダッカ～バンコク～成田
１月１１日（金）	成田着

4. 調査結果概要

（1） 有効審査の現地調査が予定とおりに実施できた。

1月5日～10日にわたって、DOE が現地を行い、PoA-DD への改善の指摘を行った。

（2） 指摘項目における改善及び今後の予定についての合意ができた。

- i、 ベースラインのおける染色技術のチャートの決定において、既存の記録データをベースに最も保守的なチャート（染色リシピ）を再確認する。
- ii、 ボイラからの CO_2 排出係数を計算するために、保守的ボイラのスペック数値を用いる。
- iii、 ポンプの効率（kwh/m^3 水）の計算のために、井戸の深さとポンプのスペック数値を用いる。
- iv、 Micro scale CDM のルールで CPA の追加性の論証を行う（W.S.T と試算の結果、殆どの工場において省エネルギー量は、micro scale の閾値以下でことは判明）。
- v、 モニタリングについて、電力は、各染色機に電力計を設置して測定する。水と蒸気の量について、携帯式蒸気流量計、水流量計で、サンプルで測定を行う。 これに関して、SSC WG から以前提出した確認事項についての電話会議の要請があり、1月11日に17：30（日本時間）に電話会議が行われた。そこ結果、a. 方法論でのエネルギーの直接測定という記述は、蒸気量また温度などの測定から熱エネルギーを計算すると解釈できるということの確認ができた。AMS-I.D また AMS-II.K におけるモニタリング要件を参考できるということでした。 b. 染色機における蒸気の量に対して、実測することには難度があることなら、保守性に保障できるような実績チャートから読み取る方法を提案することも可能であるという確認ができた。 この結果を踏まえて、W.S.T との相談の上、上述したような携帯式の蒸気流量計を用い、サンプル手法で

モニタルングを行うことで、DOE とも合意した。

5. 特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6. その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）

（1） ベースラインの設定（ベースラインにおける技術のチャートの再確認）の調整。

BANGLADESH TEXTILE FACTORY SURVEY REPORT IN THE FIELD OF ENERGY & WATER SAVING

Issued by Japan Textile Consultant' Center

Kunihiro.Morimoto

Osamu. Tabata

Keiji. Tokai

September 2012

Index

Appendix

1. General concept of JTCC Activity

◆ Our JTCC survey, there have been efforts to excavation projects eligible for CDM shown below, in the business survey commissioned by PEAR Carbon Offset Initiative Corporation to assisting that JTCC has worked as a project overseas technical supporting

◆ From the viewpoint of preventing global warming, reducing the amount of carbon dioxide emissions is the urgent issue that was imposed on the nation, in every region on earth. Intergovernmental Panel on Climate Change of the United Nations in the year 1999 (Intergovernmental Panel on Climate Change, abbreviation: IPCC), based on the arrangements for the United Nations Framework Convention on 3rd World meteorological environment was held in Kyoto. It is the so-called Kyoto Protocol. This developed countries will count in suppressing the generation amount of their own, the amount of reduction of carbon dioxide in the bill in developed countries, and reduce emissions, by applying to developing countries energy-saving technology possessed by the developed countries, was thus obtained terms of being able to have been resolved. (Clean Development Mechanism = CDM)

◆ In view of the cases CDM above, water and energy in the department dyeing textile factories of two consisted with knitting, dyeing,

and sewing where have been near Dhaka, the capital of the country Bangladesh (northern 30km from the center) was intended to measure the content consumption figure mainly in natural gas, electricity and steam in the processing equipment and facilities. And in some portion by visual data, we would give suggestions for improvement for energy and water saving.

To understand the overall condition of the site inspection, normally we are doing prior survey to the target sites..

However this time, we could not preliminary survey due to various reasons. We have developed a research plan with reference to the prior report from the company; such as Water Saving Technology Ltd is an organization that has implemented the project of environmental issues mainly water conservation in the textile dye-houses.

2. Energy and water-saving goals and research overview of Bangladesh dye houses

2-1. Background

◆ Textile dyeing and finishing industry (Hereinafter referred to as the dyeing industry) is the energy intensive industries as well as water, the process is different for every company, there is hardly any difference there such a thing as a benchmark of equipment and procedures, and water and energy consumption.

◆ Steam is applied to physicochemical some processes, which are scouring & bleaching so call preparation, and dyeing.

◆ And another heat energy which is getting by burning indirect or direct from coal, heavy oil, gas, biomass, etc..

◆ In case of steam, There is a case that receives the supply of the external or rely on the supply from the boiler of their own. Although the boiler pressure is less than 1 MPa, for a large load variation from the conditions of use that the changes are made frequently, followed by coal and biomass is difficult to load variation, tend to be too large for the consumption situation is. Electrical energy is used as the driving force of the rotating body and the pump drive these processing devices, such as a fan.

◆ For water, most of the dyeing and other steps are performed as a medium of water; soft water is used for washing and rinsing. Large variation of materials and equipment, such as lot size by its consumption, there is a continuous process and batch methods as treatment, and less consumption is a continuous process in general. However, batch processing-intensive are forced to exist in the future may not be able to adapt to the continuous process by the material.

◆ Therefore, energy and water conservation in the dyeing industry should be set up the own target which is most appropriate for your organization. And goal effort as a whole factory, the perception is particularly difficult.

To set the target for each equipment in the individual steps, and the whole together in the company or association, it sets the priority for target achievement like investment of money, goods and personnel.

2-2.Basic countermeasure for energy & water saving in Dye-houses

◆ Energy & water monitoring equipment for each machine should be given the opportunity for saving , if in case of no monitoring , saving chance have nothing in every industry. This is because you cannot set the target value of energy and water-saving if there is no monitoring of the individual facility.

◆ What is the necessary monitoring equipment?

(1) Steam flow meter,
(2) Electric power meter,
(3) Gas or other heating medium flow meter or weigh system.

Saving water is a water flow meter. These data output today has become possible, a recording unit of time, total daily dose is possible easily. Recording device temperature history of dyeing equipment, instruction set and the temperature and humidity of stenter and dryer has become mandatory as recorded in the other course. In recent dyeing apparatus control program is especially common sense; it has become the mechanism that will be memory in the recording medium and after dyeing procedural, it can be output from the dyeing machine actual figures were also based on the instructions of the program.

◆ As reference data when the dyeing result is abnormal case than the energy saving purpose, which is equipped with means to ensure the normal operation of the dyeing machine side.

◆ It is a ranking of the following energy saving if dyeing, and start with the big ones of the effect at low cost.

(1) It is keeping heat and insulation.

To prevent the dissipation of thermal insulation material without the use of naked pipes and processing equipment temperatures higher than 30 ℃ than normal room temperature.

(2) Waste heat recovery is 2nd important means. The heat energy contains in the exhaust dye liquors and drying machines, etc.

(3) Thermal energy recovery device and the drain heat exchanger should be installed in proper places.

It will be 30% of energy saving can be achieved in this part thoroughly.

Remodeling process and equipment, it is necessary to mobilize the intellect.

Make improvements in terms of energy saving and devices from the traditional process, the most important point in this case is serious consideration to quality. It is one way of the energy saving technique that decreases the energy intensity by improving productivity.

(4) Making and organizational mechanism to centralize the management of energy and water as a result of the above improvements can be validated by the corporate site is necessary. And cost balance is an important task of the utility department, their main target are efficient operation of boilers, drainage and maintenance of reference heat and water facilities.

3. Factories' evaluation of investigation

- Factories which have been surveyed this time, it is a leading company in Bangladesh dyeing factory; we can also guess that HP and company size. Looking at it from that you have referred to as water-saving dispatching guidance (WST) and the Ambassador of Water Saving Technology Ltd is also the coordinator of the survey; the higher the priority of the two factories is expected in particular.
- Technical support team also JTCC, energy and water-saving technique for investigation has been mastered from the experience in India, Indonesia, and China. As walk through mission is performed prior to the actual research usually, inevitably face the site without rehearsal this time, I had a hard time in the selection of measurement equipment.
- Two plants in Bangladesh are in a state of almost untouched to the extent that has worked on some of the condensed vapor recovery activities on energy conservation has not been done, utility manager has a little interest in them.
- It is scandalous not done well in boilers, the fuel consumption and the water supply is a particularly important figure. It has not been carried out because WST is also contained in the guidance water consumption, but it would not have been grasped by the measuring instrument or the like. Any kind subjected to saving energy and monitoring has not been granted. Measuring instrument is not equipped with any expression, but also all gas direct heating to stenter and dryer which are consumed a lot of energy in the dyeing factory.
- Dyeing machines have standard program control device manufactured by Sedex. The dyeing program has been structured to be set in each of the machine following the production order sheet together with fabrics. And the memory card can be sucked up the feedback data of temperature history in dye bath, but data management dyeing feedback has not been carried out with both plants.
- Subject to this survey is different, "color matching" is also big theme The important dyeing companies are (Color matching).
- Most have not been used but has introduced a system of Datacolor Inc (USA). With the department dyeing, one company had been also utilized light source device standard incidental thereto, another company has to check the sample dyeing under fluorescent lights of the room, and this is extremely problematic also there.
- To check the dyed color by the light source in the standard measures is essential for right color matters.
- Knitting → dyeing → Sawing procedure has been carried out in the same location, two plants which have been surveyed; the situation is very favorable in terms of logistics and QR (Quick Response Production). So final garment product can get immediately after dyeing and finishing.
- Sample making is always needed short production term. Here sample product can get within a few days after product planning. as a business system is a huge advantage It takes a month at least in Japan for sample making.

- At LFL, water pipe and steam line are much complicate, so it is very difficult to look for the final places in consumption.

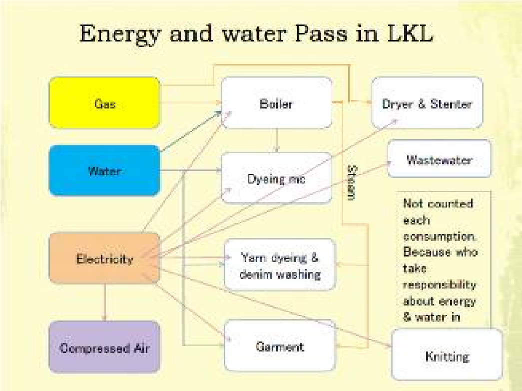


Figure 3-1 Energy & water supply network in LFL

4. Countermeasures for energy & water saving in BGD

As above mentioned, two factories have no monitoring system or measurement tools. All the data that is to give some guidance to those factories should be collected within short terms.

And even taken the data there, but those are only one time or few hours record, therefore figures are not always exact, may be.

Please read over our countermeasures after understanding our situation.

4-1 Energy saving from Dyeing process (Utilization of cooling water)

Two factories have carried on dyeing by High-pressure Jet dyeing machine which are round type. Dyeing materials are 100% knitted fabrics that are produced by them and some are bought from other parties.

As mentioned above chapter, both factories not well managed warmed cooling water.

LTL has sent cooling water to main soft water pit, and GKL has sent to boiler after mixed with condensed water. Warmed cooling water have to keep in isolated tank nearby dyeing machine, and apply to dyeing or hot rinsing, so both factories can be saved 25% steam saving.

4-1-1 Composition of dyeing materials

Material composition is very important factor to investigate energy and water consumption in dye-houses. About this, we got information from W.S.T about GKL, but not LFL

GKL's rate is as follows,

Table 4-1Mmaterial occupation rate for dyeing in GKL from W.S.T report

Materials	CVC	Cotton	Polyester
Rate	10%	60%	30%

And for cotton or CVC, reactive & direct dyes are occupied 50:50 (estimation). However analysis makes more difficulty to finalize, therefore cotton dyeing has made 2 groups as follows,

Table 4-2 Dyeing program in each material and its statistical group to simplify

Materials	CVC	Cotton		Polyester
Dyes combination	Disperse +Reactive	Reactive	Direct	Disperse
Rate	10%	30%	30%	30%

According to LFL' composition is not clear, so our calculation is used Table 1 as components. Naturally dyeing materials in occupation is changed quite big amount depending on seasons, fashion trends and market condition.

Therefore material composition is difficult to fix in the factories which are dyeing many type of materials. (In Japan, Thailand and Indonesia, dyeing materials are fixed in each dye-house. China is same style as BGD)

4-1-2. combination dyeing and white color

In case of CVC, two kinds of dyes are used normally, but sometimes only one side (cotton or polyester) is dyeing. Our calculation is based on both side dyeing. And white is one kind of dyeing particularly for polyester.

And our calculation is based on medium color. In case of light color (included white) is less energy and water about 20%, and heavy color is more 20%. That reasons are retention time of dyeing process, but also hot and cold rinsing times are more and less.

4-1-3. Dyeing program

In modern dyeing system or machine dyeing method is fundamentally different from handmade craft; especially dyeing process is carried on automatic systems.

Therefore modern dyeing machine is adopted computerized system to achieve "right color" batch by batch in best way.

Dyeing program is based on color matching particularly less chance for re-dyeing.

Every dye-house always wants to improve the dyeing program, and every dye-house use individual dyes and machine combination, therefore dyeing program is different each other. In case of combination dyeing, the program should become more complicate.

For two investigation factories, W.S.T gave us each factories dyeing program.

We think that is their standard or common programs, so our suggestions follow by those programs and for your reference, we put on our standard too.

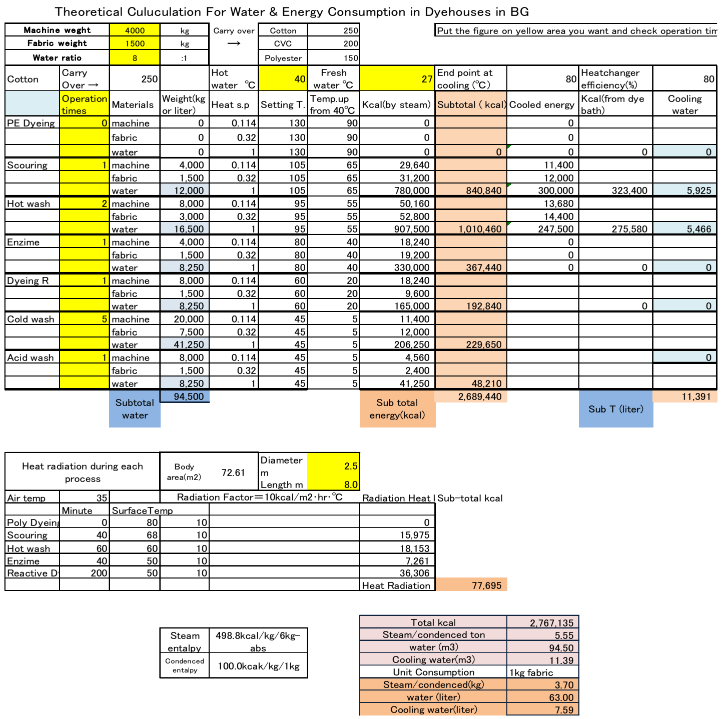
4-1-4.Energy and water demand quantity from dyeing program (calculation shown by excel sheet by Excel file)

To estimate the energy and water consumption in dyeing process, we must set up assumption.

Table 4-3 Model scheme for general condition in dyeing in BGD

Property	Requirement	Property	Requirement
Fabrics	CVC,Cotton,PET	Dye bath ratio	1:8 or 1:6
Machine	HP JET	Carry over	150 to 250%
Fabric weight	1500kg/batch	Water temp	30℃→40℃
Fabric weight	150kg/batch	Cooling water	30℃→27℃
Dyes for PET	Disperse	Washing or Rinsing	No overflow (Step by step system)
Dyes for Cotton	Reactive or Direct		
Dyes for CVC	Disperse +Reactive		

Table:4-4 One sample from Excel sheet for energy and water saving calculation



Theoretical Culuculation For Water & Energy Consumption in Dyehouses in BG

Machine weght		4000	kg	Carry over →	Cotton	250		Put the figure on yellow area you want and check operation tim			
Fabric weight		1500	kg		CVC	200					
Water ratio		8	:1		Polyester	150					
Cotton	Carry Over →	250		Hot water ℃	40	Fresh water ℃	27	End point at cooling (℃)	80	Heatchanger efficiency(%)	80
	Operation times	Materials	Weight(kg or liter)	Heat s.p	Setting T.	Temp.up from 40℃	Kcal(by steam)	Subtotal (kcal)	Cooled energy	Kcal(from dye bath)	Cooling water
PE Dyeing	0	machine	0	0.114	130	90	0		0		
		fabric	0	0.32	130	90	0		0		
		water	0	1	130	90	0	0	0	0	0
Scouring	1	machine	4,000	0.114	105	65	29,640		11,400		
		fabric	1,500	0.32	105	65	31,200		12,000		
		water	12,000	1	105	65	780,000	840,840	300,000	323,400	5,925
Hot wash	2	machine	8,000	0.114	95	55	50,160		13,680		
		fabric	3,000	0.32	95	55	52,800		14,400		
		water	16,500	1	95	55	907,500	1,010,460	247,500	275,580	5,466
Enzime	1	machine	4,000	0.114	80	40	18,240		0		
		fabric	1,500	0.32	80	40	19,200		0		
		water	8,250	1	80	40	330,000	367,440	0	0	0
Dyeing R	1	machine	8,000	0.114	60	20	18,240				
		fabric	1,500	0.32	60	20	9,600				
		water	8,250	1	60	20	165,000	192,840		0	0
Cold wash	5	machine	20,000	0.114	45	5	11,400				
		fabric	7,500	0.32	45	5	12,000				
		water	41,250	1	45	5	206,250	229,650			
Acid wash	1	machine	8,000	0.114	45	5	4,560				0
		fabric	1,500	0.32	45	5	2,400				
		water	8,250	1	45	5	41,250	48,210			
		Subtotal water	94,500			Sub total energy(kcal)		2,689,440		Sub T (liter)	11,391

Heat radiation during each process			Body area(m2)	72.61	Diameter m	2.5
					Length m	8.0
Air temp	35		Radiation Factor＝10kcal/m2･hr･℃		Radiation Heat l	Sub-total kcal
	Minute	SurfaceTemp				
Poly Dyeing	0	80	10		0	
Scouring	40	68	10		15,975	
Hot wash	60	60	10		18,153	
Enzime	40	50	10		7,261	
Reactive D	200	50	10		36,306	
					Heat Radiation	77,695

Steam entalpy	498.8kcal/kg/6kg-abs
Condenced entalpy	100.0kcak/kg/1kg

Total kcal	2,767,135
Steam/condenced ton	5.55
water (m3)	94.50
Cooling water(m3)	11.39
Unit Consumption	1kg fabric
Steam/condenced(kg)	3.70
water (liter)	63.00
Cooling water(liter)	7.59

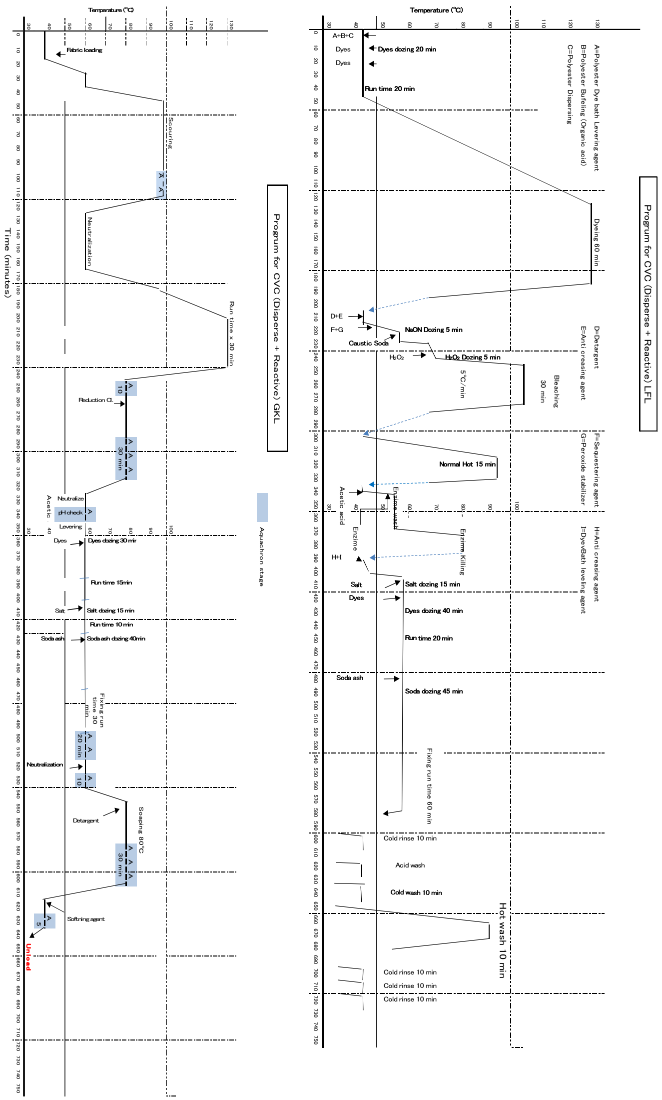


Figure:4-5. Dyeing program for CVC in both factories

Table:4-1. Final result in saving of steam & cooling water in dyeing process (estimation from dyeing program)

	For one batch			Per one kg Fabric			
	Fresh water	30°C	Cooling water	30°C	Fabric weight(kg	1500	
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	10.33	111.00	27.66	6.9	74.0	18.4	1:8
Cotton(Reactive)	7.67	94.50	11.96	5.1	63.0	8.0	1:8
Cotton(Direct)	7.54	78.00	21.43	5.0	52.0	14.3	1:8
Polyester	7.81	60.75	27.51	5.2	40.5	18.3	1:8
	Fresh water	30°C	Cooling water	30°C	Fabric weight(kg	150	
THIES 1	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	0.85	7.50	2.19	5.7	50.0	14.6	1:6
Cotton(Reactive)	0.83	9.45	1.27	5.6	63.0	8.5	1:8
Cotton(Direct)	0.85	7.80	2.34	5.7	52.0	15.6	1:8
Polyester	0.67	4.28	2.20	4.5	28.5	14.7	1:6

	Fresh water	40°C	Cooling water	27°C	Fabric weight(kg	1500	
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	7.88	111.00	26.39	5.3	74.0	17.6	1:8
Cotton(Reactive)	5.55	94.50	11.39	3.7	63.0	7.6	1:8
Cotton(Direct)	5.46	78.00	20.35	3.6	52.0	13.6	1:8
Polyester	6.48	60.75	26.26	4.3	40.5	17.5	1:8
	60.75	40°C	Cooling water	27°C	Fabric weight(kg	150	
THIES 1	26.258163	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	0.66	7.50	2.08	4.4	50.0	13.9	1:6
Cotton(Reactive)	0.60	9.45	1.21	4.0	63.0	8.1	1:8
Cotton(Direct)	0.66	7.80	2.22	4.4	52.0	14.8	1:8
Polyester	0.56	4.28	2.10	3.8	28.5	14.0	1:6

	For one batch			Per one kg Fabric			
Fabric Wt:1500kg	Fresh water Temp.chenge	30→40°C	Cooling water Temp. change	30→27°C			
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	▲ 23.7	0.0	▲ 4.6	▲ 23.7	0.0	▲ 4.6	1:8
Cotton(Reactive)	▲ 27.6	0.0	▲ 4.8	▲ 27.6	0.0	▲ 4.8	1:8
Cotton(Direct)	▲ 27.6	0.0	▲ 5.0	▲ 27.6	0.0	▲ 5.0	1:8
Polyester	▲ 17.0	0.0	▲ 4.6	▲ 17.0	0.0	▲ 4.6	1:8
Fabric wt.150kg	Fresh water Temp.chenge	30→40°C	Cooling water Temp. change	30→27°C			
THIES 1	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	▲ 22.3	0.0	▲ 4.6	▲ 22.3	0.0	▲ 4.6	1:6
Cotton(Reactive)	▲ 27.6	0.0	▲ 4.8	▲ 27.6	0.0	▲ 4.8	1:8
Cotton(Direct)	▲ 22.3	0.0	▲ 5.0	▲ 22.3	0.0	▲ 5.0	1:8
Polyester	▲ 15.7	0.0	▲ 4.6	▲ 15.7	0.0	▲ 4.6	1:6

For both factories, we try to calculation to four kinds of material follow with dyeing program. We get result as below.
Warmed cooling water should be kept in proper tank or pit, then use it process directly.

4-1-5. Saving amount and some paradox between calculation & actual

It is very easy to understand that water and heat energy saving is done by utilization of warmed cooling water from Jet dyeing machines.

By estimate, almost 25% steam and 5% cooling water can be saved by warmed cooling water management.

When we made calculation to save water & steam, we made **Table4-7.** At the same time, we have analyzed experimental data for both factories water and steam supply.

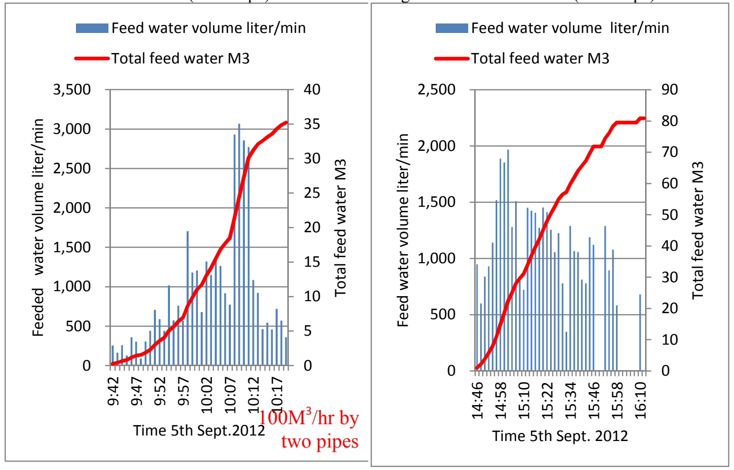
Table:4-7 Estimated water & steam consumption in dyeing process in both factories

	Landmark Fabrics Ltd				**Grameen Knit wear Ltd**			
Materials	CVC	Cotton(R)	Cotton(D)	Poly100%	CVC	Cotton(R)	Cotton(D)	Poly100%
Production rate	10	30	30	30	15	30	30	25
Total Production/day			15.0	ton			10.0	ton
Water consumption/ton	92.4	71.0	66.3	58.8	92.4	71.0	66.3	58.8
Total Water Consumption each item/day	138.6	319.5	298.4	264.6	138.6	213.0	198.9	147.0
Total water/day	**1,021.1**				**697.5**			
Actual Consumption/day	2,400.0 *1		(1,080.0) informed		1,150.0 *2		(992) informed	
Difference from calculation	235.1% (105.8%)				164.9% (142.2%)			
Total Steam Consumption/ton	6.9	5.1	5.0	5.2	6.9	5.1	5.0	5.2
Total Steam Consumption each item/day	10.4	23.0	22.5	23.4	10.4	15.3	15.0	13.0
Total Steam consumption/day	**79.2**				**53.7**			
Actual Consumption/day	306.0 *3 (50% steam for Dyeing)				113.0 *4			
Difference from calculation	189.3%				210.6%			

Total: By calculation from dyeing program
Actual consumption (water & steam *1,* 2,* 3,* 4): From data collection by measurement.
Informed: received figure from W.S.T (LFL), from company accountant (GKL)

* Landmark factories have two pipelines and supply water many area in factories.

Left side to boiler in LFL (No.1 Pipe)   Right side to boiler in LFL(No.2 Pipe)



100M^3/hr by two pipes

Figure: **4-2** Water volume to supply all factories except boilers in LFL(prompt data)

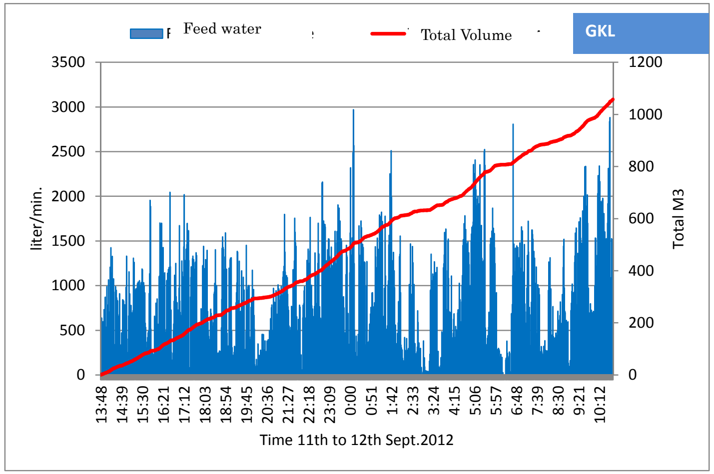


Figure: **4-3** Water volume supplied to dyeing &finishing in GKL (whole day data)

From **Table 4-7**, we can find some question, because value differences from total one and actual consumption.

According to calculation, we don't include other section's consummation (boiler water, lab works, office and finishing section), and some extra works at dyeing section itself; re-dyeing, machine cleaning and toilet)

Particularly LFL's pipe line for water & steam is very complicated. They have another two or three factories, like hunk dyeing, denim washing and sewing thread dyeing.

Therefore above figure have contained its consumption as well.

More detail of steam supply is shown **Table 4-14**.

Table 4-8 water saving amount by cooling water management

Cooling water consumption & Reducing amount liter/kg-fabric

			Landmark		Grameen	
Material	Dyeing W	Cooling W	Rate	Share	Rate	Share
CVC	74	18.4	10	1.84	15	2.76
C (React)	63	8	30	2.40	30	2.40
C (Direct)	52	14.3	30	4.29	30	4.29
PET	40.5	18.3	30	5.49	25	4.58
Average			Av.water	14.02	Av.water	14.03
Production/day	ton			15		10
Water for Cooling	m3			210		140
Saving amount (rate 5%)	m3			11		7

Table:4-9 Saving steam quantity from warmed cooling water

	Landmark Fab.	Grameen knit
Total steam consumption/day-ton	79.2	53.7
Saving rate	25%	25%
Saving amount/day-ton・steam	19.8	13.4
Saving amount/ton-steam/year	5,940	4,020
Saving energy/year	16,260GJ	11,000GJ
Cost saving/year (Tk)	3,200,000	2,180,000

0.4MPa-steam:2,738kJ/kg, 1m3gas:14.7kg-steam, 1ton-steam=544Tk

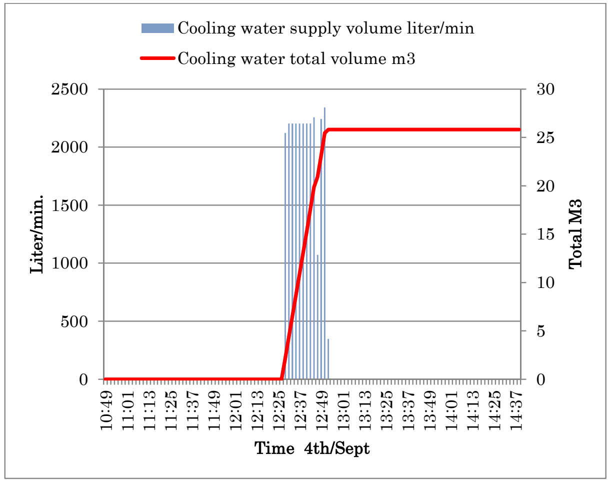


Figure: 4-4 Cooling water supply condition Fong's 1500kg Dyeing machine

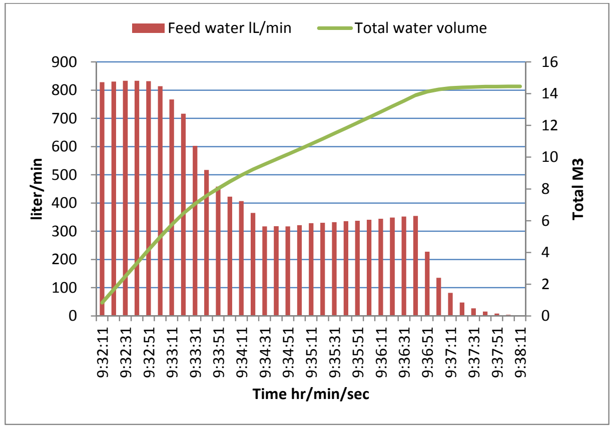


Figure: 4-5 Cooling water supplies for Japanese dyeing machine PIV controlled (reference)

◆ Cooling water supply condition must be pay attention, sudden water is not well effect, particularly at intermediate of cooling process, water supply should be reduced its volume to make efficiency increase.

4-2. Heat recovery from dye-bath wastewater

Dyeing process is used hot water in dye-bath. After finish each step, dye-bath water is exhausted time by time.

Those exhausted drain is go to wastewater treatment plant without any heat recovery in BGD.

To take back heat energy from waste is primitive technology for energy saving.

By our experiment to waste from dye-bath, temperature peak is shown in reference figures

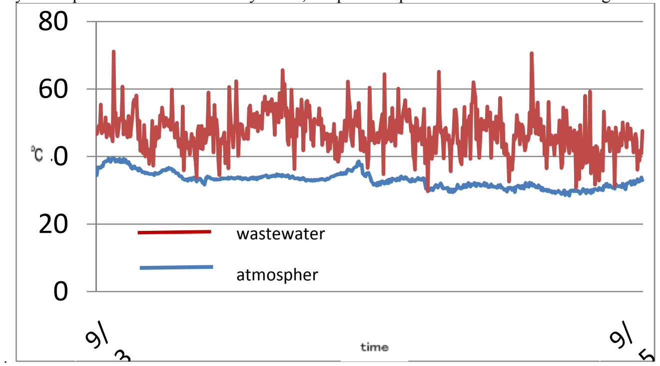


Figure:4-6 dyeing machines (Thies No.5) wastewater temperature in LFL

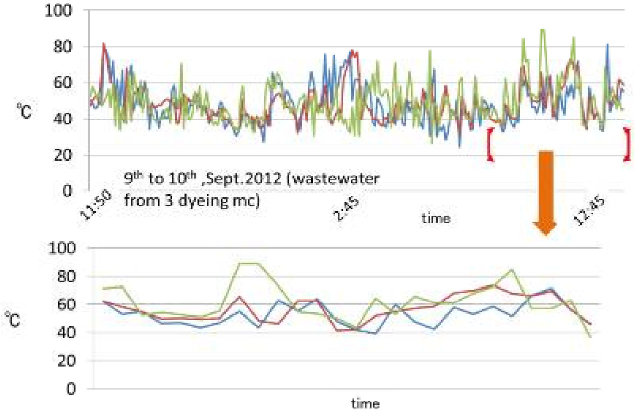


Figure:4-7 3 dyeing machines wastewater temperature in GKL

Table:4-10 Hot wastewater volume from dye-bath

	CVC		Cotton(Reactive)		Cotton(Direct)		Polyester	
1500kg fabrics	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.
Dyeing	9,000	130			9,000	95	9,000	130
Scouring	9,000	105	9,000	105	9,000	105		
Hot wash	18,000	95	18,000	95	18,000	95	9,000	95
Enzime	9,000	80	9,000	80	9,000	80		
Total water	45,000	75	36,000	75	45,000	75	18,000	75
		30%		30%		30%		10%
	13,500		10,800		13,500		1,800	
Average/rate for 1500kg-fabric			39,600 liter/1,500kg-fabric					
Average liter/kg-fabric			26.4 liter/kg-fabric					

Supposing to collect all waste heat from dye-bath, and thermal exchange by exchanger, the next value can be saved

Table 4-11 Energy saving value by heat exchanger from wastewater

	Landmark Fabric Ltd	Grameen Knit wear Ltd
Production ton/day	15	10
Wastewater volume	26.4m3x15tons=396m3	26.4m3 x 10tons=264m3
Outlet Temp. from heat exchanger	75℃-15℃=60℃	75℃-15℃=60℃
Heat recovery energy/day	(60℃-30℃) x 396m3=11,880Mcal	(60℃-30℃) x 264m3=7,920Mcal
Eq.steam quantity/day	11,880Mcal/650kcal=18.2ton	7,920Mcal/650kcal=12.2ton
Energy saving rate *1	18.2t/79.2t=23%	12.2t/53.7t=23%
Energy saving rate *2	18.2t/306t =6.0%	12.2t/113t=10.8%
Energy saving/year	3,564Gcal=14,922GJ	2,376Gcal=9,931GJ
Cost saving/year (Tk)	18.2ton x 300 x 544=3,000,000	12.2ton x 300 x 544=2,000,000

*1: Saving rate is based on dyeing energy by idealized figures

*2: Saving rate is based on all energy consumed at the moment.

4-3. Heat recovery by insulation for dyeing machine

High temperature dyeing machine is radiating quite big heat energy during one by third in dyeing time.

Long tube type dyeing machine which is used in Asia area is insulated in common.

But in hot country, insulation has been neglected. And round type is quite difficult to insulation. We try to calculate if possibly have done insulation.

Table: 4-12 Dyeing machine surface insulation effect for energy saving

Landmark Fabric				**Grameen Knit**			
m/c No.	Diameter mm	Length mm	Area(M^2)	m/c No.	Diameter mm	Length mm	Area(M^2)
T1	2,350	2,280	25.49	Athena	2,400	5,134	47.73
T2	2,300	4,200	38.64	AT-4	1,500	4,000	22.37
T3	2,300	4,200	38.64	HT-3	1,500	3,700	20.96
T4	2,300	4,200	38.64	HT-1	1,500	1,900	12.48
T5	2,300	4,200	38.64	HT-4	1,500	3,700	20.96
T6	2,300	4,300	39.36				
F1	2,300	3,500	33.58				
F2	2,300	4,200	38.64				
F3	2,300	4,330	39.58				
F4	2,400	8,000	69.33				
Total(M^2)			400.53	Total(M^2)			124.51

	Landmark Fabric		**Grameen Knit**	
Average Surface Temp	70	℃	70	℃
Atmosphere Temp.	30		30	
Higher temperature time	8	hrs	8	hrs
H.Radiation rate (kcal/hr/℃/m2)	10		10	
H.Radiation rate by insulation (kcal/hr/℃/m2)	2		2	
Energy saving effect (Mcal/day)	1,025(1.57t-steam)		319(0.49t-steam)	
Energy saving /year (GJ/year)	1,285GJ		400GJ	
Saving cost (Tk)/year	1.57 x 300 x 544=256,000		0.49 x 300 x 544=80,000	

4-4 Electric consumption in Dyeing machine

◆ Electric power energy are used for fabric transportation by winch wheel and Jet water circulation pomp in dyeing machine.

Drum type dyeing machine which have been improved in Europe is first experience for us to investigation.

In Japan and many south Asia countries, long tube type dyeing machine is common.

In case of long tube, we never saw more than 500kg-fabric load. And in case of 500kg-fabric load, main motor capacity to circulate fabric & water is 55kW, and operation load 25kW.

In the other hand, drum type machine electric power is very small, even 1500kg-fabric Sclavos is consumed 13.5kW. Supposing long tube type Jet machine is operated as same load, electric power should be needed 6 times of Drum type one.

As well as inverter speed controller is adopted too, electric energy has been able to reduce more.

We have learned that drum type dyeing m/c is much energy saving than our tube type dyeing machine.

It means that for dyeing machine it is less energy saving potential.

Table 4-13 Dyeing machine operation power

11th Sept. 11:00～

Machin No	Item	Total Power			Main		Main Moter			Load Rate
		kW	hP	A	A	kW	A	kW	HZ	%
AHT−4	1st	39.54	53	85	22.5	13.25	21.0	12.37	41.4	
	2st				26.5	15.61	25.0	14.72	41.4	
	3st				20.0	11.78	18.0	10.60		
	Av					13.54		12.56		34.25
HT−3	1st	23.5	31.5	42	16.6	9.78	13	7.66	45.9	
	2st				13.8	8.13	12	7.07	45.9	
	3st				13.8	8.13	12	7.07	45.9	
	Av					8.68		7.26	45.90	36.92
HT−1	1st	13.43	18	27	7.3	4.30	6.5	3.83	46.5	
	2st				5	2.94	4.3	2.53	46.5	
	3st				6	3.53	5	2.94	46.5	
	Av					3.59		3.10		26.75
AT−4	1st	26.86	36	54						
	2st									
	3st				16	9.42	13.4	7.89	45.6	
	Av					9.42		7.89		35.07
HT−4	1st	24.62	38	84	18.5	10.89	15.2	8.95	45.9	
	2st				16.2	9.54	14.2	8.36	45.9	
	3st				16	9.42	13.4	7.89	45.9	
	Av					9.95		8.40	45.9	40.42

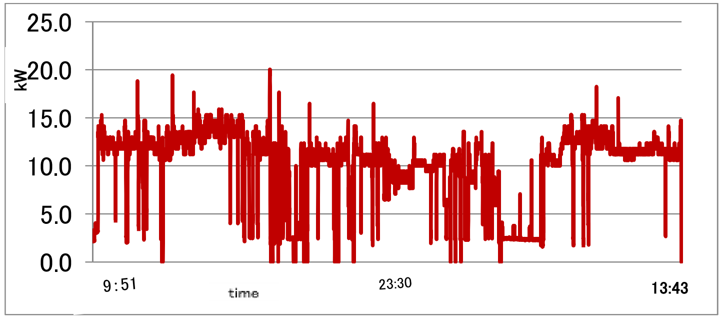


Figure 4-8 Dyeing machine pomp motor loads (Fong's No.4 in LFL)

- In both factory, all dyeing machines are controlled by inverter system, but speed reduction is only the beginning and ending time, and during dyeing operation, fabric speed is not varied linked with dyeing programs.

4-5.Stenter & Dryer

- Usually when we are going energy investigation in dye-houses. The first target is stenter, because this machine consumes a lot heat and electric energy in every dye-house.
  The first step in research is look over the fuel consumption record, and electric power record.
  After checking both record and monitor gauge, we investigate operation condition.
- At both factories, they have no monitoring instrument, and consumption record.
  Natural gas is main heating fuels for dryer and stenter, and direct burning system.
  We have nothing to catch up devises for gas consumption.
  And both factories' machine is stopping very often, therefore we gave up to take thermal data collection.

- All stenter have been very poor maintenance.
  In dye-house, stenter speed or operation efficiency is covered with total production capacity.
  Therefore stenter must be kept the best condition in all over days.
- Circulation fans for one chamber are broken in GKL Turkey made stenter , and some burner trouble in LFL Germany stenter.
- Pinning operation is basic function on stenter, but in both stenter, some pin sheets have serious brake. Broken pin-sheets should be changed immediately, otherwise machine productivity go down seriously.
- What is reason to stop machine very often, this stenter has interlocked with fan motors, so when every operation stop caused, fan motors stopping, therefore chambers inside is no hot air circulation. Very often machine stop make very lower efficiency and lower production.
  Machine speed has some tolerance by checking taco-meter.
  Within one hour, how many times stenter stop? **(Figure 4-9,10)**
- Some doors' packing became loose, then hot air leaking. Dryer has soaked cool air from lint filter space.
- LED monitoring device have worn out, so indicated figure cannot see clearly.

Table 4-16 Stenter motors condition ALKAN (Tarky made)

Item		Rating output	Measurement value			Power factor	Output	Load factor
			Voltage	Ampere	Frequency		Calculated value	
		kW	V	A	Hz	%	kW	%
1	Main chain drive Motor	7.5	399	8.6	42	85	5.1	67
2	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.5	42	85	5.0	33
3	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	9.6	42	85	5.6	38
4	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.5	42	85	5.0	33
5	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.3	42	85	4.9	33
6	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	9.4	42	85	5.5	37
7	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	-	-	-	-	-	Stop
8	Exhaust Fan Drive motor	7.5	399	5.7	24	85	3.3	45
9	Padder Roller Drive Motor – 1Pcsx11 kw	11.0	399	8.4	16	85	4.9	45
10	Padder Roller Drive Motor – 1Pcsx11 kw	11.0	399	5.0	14	85	2.9	27
11	Infeed Upper Roller Drive Motor	4.0	399	2.7	14	85	1.6	40
12	In feed Lower Roller Drive Motor	4.0	399	2.4	12	85	1.4	35
13	Others Load	49.4	399	6.3	-	85	3.7	7
Total		184.4	399	83.4	-	-	49.0	27

Stenter & stenter burner in LFL

Stenter (Tarky) and Dryer burner in GKL

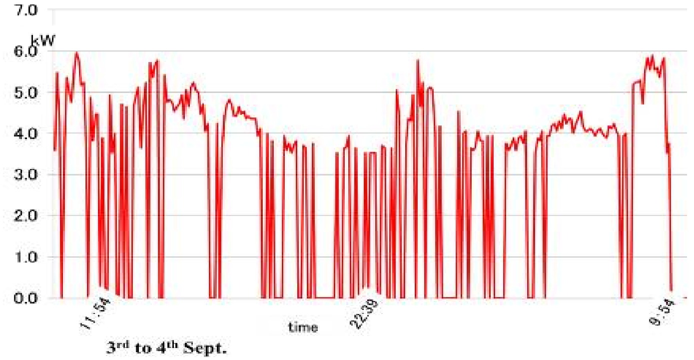


Figure 4-9 Stenter main motors operation LKL

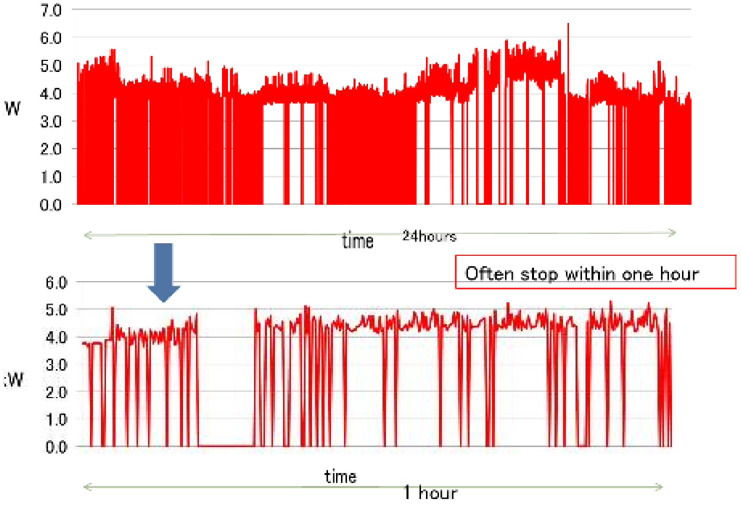


Figure 4-10 Stenter main motors operation (GKL)

4-6 Washing off effect

- Washing process need more water and energy. Dyestuffs selection is one point to reduce them.
- Direct dyes are one selection, because dye- liquor is not much contamination as reactive dyes.
- Aquachron rinsing is suitable for polyester 100%, but for cotton need plenty water. For reactive dyes, batch style rinsing can reduce water and energy.

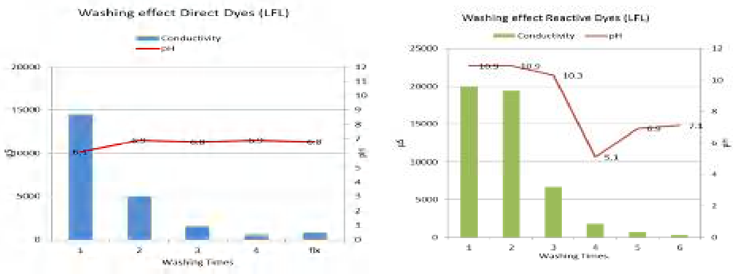


Figure 4-11 Washing effect by Direct Dyes **Figure 4-12 Washing effect by Reactive Dyes**

Figure 4-13 Wastewaters from rinsing bath (LFL)

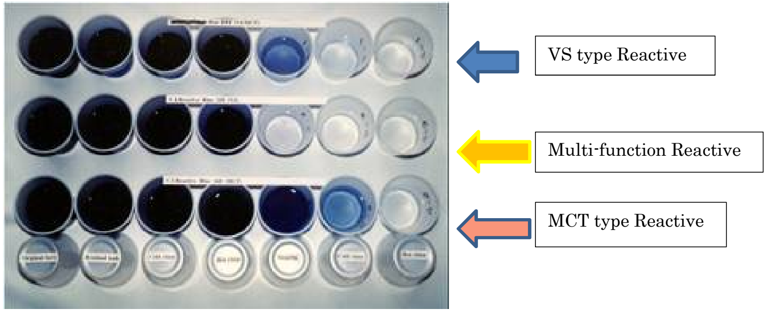


Figure 4-14 washing off comparison (for reference)

Sclavos: AquaChron Dye Rinsing System

As jet dyeing technology has evolved over the last 20 years, much focus has been placed on lowering liquor volume during processing to improve the dyeing parameters. Liquor ratios have been lowered from 20:1—30:1 in the early days to 5:1 or lower today. These changes have produced cost benefits in dyeing but at the expense of making dyeing more difficult and rinsing much more inefficient and time-consuming. When you consider that, with reactive dyes, 70% of the processing time, 80% of utilities and 90% of the water used is during rinsing, it is obvious that this is a great expense for the dyehouse and an area of needed improvement.

By: Sclavos SA

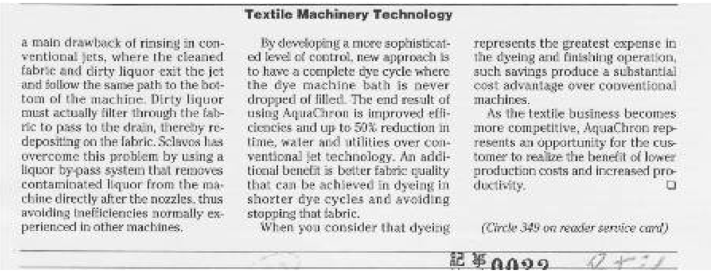
AquaChron improves efficiencies and reduces time, water and utilities up to 50% compared to conventional jet technology

Recognizing this, Sclavos SA developed the AquaChron rinsing system in its new Venus dye machine. AquaChron is a revolutionary water/time management system that has resulted in a dramatic increase in rinsing efficiency over conventional dyeing technology.

AquaChron, uses the Twin Soft Flow nozzle system. As most rinsing occurs at the jet nozzle, two soft-flow jets in tandem yield an increased intensive zone. By combining these two nozzles with an elbow pipe, this critical intensive zone is enlarged to provide more than eight time the area of contact over that of conventional machines.

For this reason alone, fabric has more contact points with the liquor. When rinsing, fabric leaves this area cleaner with each pass. At the same time, liquor exits in a more contaminated state. Use of the Twin Soft Flow also has boosted fabric quality. Moving away from liquor pressure at the nozzle to liquor volume to move the fabric eliminates many problems such as pilling, creases and rope marks. This improvement occurs in all fabric categories, from plain knits and wovens to more difficult fabrics such as those with stretch properties.

The next development centers on



a main drawback of rinsing in conventional jets, where the cleaned fabric and dirty liquor exit the jet and follow the same path to the bottom of the machine. Dirty liquor must actually filter through the fabric to pass to the drain, thereby redepositing on the fabric. Sclavos has overcome this problem by using a liquor by-pass system that removes contaminated liquor from the machine directly after the nozzles, thus avoiding inefficiencies normally experienced in other machines.

By developing a more sophisticated level of control, new approach is to have a complete dye cycle where the dye machine bath is never dropped of filled. The end result of using AquaChron is improved efficiencies and up to 50% reduction in time, water and utilities over conventional jet technology. An additional benefit is better fabric quality that can be achieved in dyeing in shorter dye cycles and avoiding stopping that fabric.

When you consider that dyeing represents the greatest expense in the dyeing and finishing operation, such savings produce a substantial cost advantage over conventional machines.

As the textile business becomes more competitive, AquaChron represents an opportunity for the customer to realize the benefit of lower production costs and increased productivity. ☐

(Circle 349 on reader service card)

(Refer from Textile world USA; April 1998) Copy by Japan Science & Technology Agency

4-7 Dyestuffs and chemicals

Our investigation is not subject for “Right color first time”, but some serious maters we can point out.

◆ Dyestuff storage

Weigh of dyestuffs is very important for right color, but sometimes people not concentrate the place where dyes are kept properly. The main point is how to prevent from moisture content and how to prevent humans’ health from dyestuffs dust.

You may understand easily that a fresh dyestuff which is taken from new packing is keeping for few days in atmospheric condition; weight of dyestuffs is different before and after.
Most of dyes can soak moisture about 10% in high humidity countries.
Therefor after open the package of dyes, it must keep some container to prevent from moisture and circumstance must keep cool & dry.
Sometimes we can see working people make cleaning water splash floor in dyestuffs room.
It is prohibited to splash water on floor of dyestuffs storage area.

◆ Common salt

Two factories in BGD, as common salt, sodium sulphate crystalized (Glaber salt) is adopted, but it is quite difficult to solve in water particularly in case of big amount, after put in dosing tank, it must keep long time to perfect solving. To make easy and correct method is making concentrated solution (50%) in other area, and send it to machine side by pomp.
Chemical preparation time can make shorter and achieve right color.

Dyestuffs keeping properly

Floor cleaning prohibit using water, needed ventilation system

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5. Energy conservation in utility section (Landmark fabric ltd.)

5-1 Steam condensate recovery

- ◆ In case of heat up substances, mainly latent heat in steam gives it function. After heating steam condensate is flush out from steam traps. Condensate has no latent heat, but still have sensible heat more less 100℃。
- ◆ Condensed drainage is not only useful for heat energy, but also water souse.
- ◆ The recovery system of condensed water is two ways. One is open system and other is closed one. Open system is going under atmosphere condition and closed system is under pressured condition.
- ◆ In case of open system, maximum temperature of condensed is 100℃, but investment is quite lower. On the other hand, closed system can be get condensed water in higher temperature. Therefore, closed system has advantage in the efficiency of recovering.
- ◆ For condensed recovery in LFL, open system is recommendable, and already they have start new pipe installation.

Under the moment situation, expected result will be shown below,
Heat energy reserving: water evaporation= 306ton/day (by measurement of boiler water), Recovery rate:85%, Steam drain temperature:90℃
306ton/day×0.85×(90℃-40℃）=13,000Mcal/day 13,000Mcal/306t=42℃
54.36GJ/day×300day/year=16,308GJ/year (Energy saving/a)
Boiler feed water temperature will be reach to 80℃, if condensed drain will be used only for boiler water, don’t mixe to dyeing feed water tank.

Table: 5-1 Steam feeding pipe line from 3boilers

Pipe section area			Operation time	Steam		Steam use
inch	mm	cm2	hrs.	ton/hr.	ton/day	
6	150	177				Boiler inlet
6	150	177				Boiler inlet
4	100	79				Boiler inlet
Total		432		14.2		
1	25	5	24	0.08	2.0	Feed tank
2	50	20	10	0.33	3.3	Accessories Factory
4	100	79	24	1.32	31.8	Washing plant
3	75	44	10	0.74	7.4	Garments iron
3	75	44	10	0.74	7.4	Sweater iron
3	75	44	10	0.74	7.4	Sweater iron
4	100	79	24	1.32	31.8	Dyeing (Jet)
6	150	177	24	2.98	71.5	Dyeing (Jet)
6	150	177	24	2.98	71.5	Yarn dyeing
6	150	177	24	2.98	71.5	Fong's dyeing
Total	-	839	-	14.2	306	

5-2 Exhaust heat recovery from boiler chimney

- ◆ According to boiler efficiency, exhaust air from boiler chimney must keep in mind.
  To make higher efficiency in boiler, the most interesting matters are heat recovery from chimney air.
- ◆ Boiler attendant put on record about boiler condition in quite often.
  Table 5-2 is copied from record, No.1 boiler was shown as214℃, No.2 boiler was 213℃. As it was high degree, so heat recovery has made the efficiency higher.
- ◆ Heat recovery amount from exhaust air is shown as below;

Theoretical air volume for boiler combustion: A_0
Theoretical exhaust air volume for boiler combustion: Go

Those parameters are introduced “*Boie*” formula.
HL: Feverish value by joule unit
A0 and G0 are introduced following calculation.
Ao=(2.957×HL/10,000)-3.91＝2.957×41,800/10,000-3.91＝10.57Nm3/m3
Go=(3.763×HL/10,000)-3.91＝3.763×41,800/10,000-3.91＝11.29Nm3/m3
Actual volume of exhaust=Go+（m-1）×Ao＝11.29+（1.4-1）×Ao＝11.29+（1.4-1）×1057＝15.52Nm3/m3
m : oxygen content rate→oxygen content before burning in air/oxygen content after burning in exhaust air →almost 1.4 (is ideal figure)
Fuel amount for burning(G)×Specific heat of exhaust air×（exhaust air temp - exhaust air temperature after transfer heat energy）＝15.52×998×1.38×（214-120）＝2,009,228kJ/hr（480,676kcal/hr）: 47m3 natural gas equivalent
Total annual energy saving =2,009MJ/hr×24hr×300day/a/1,000,000=14,466GJ/a

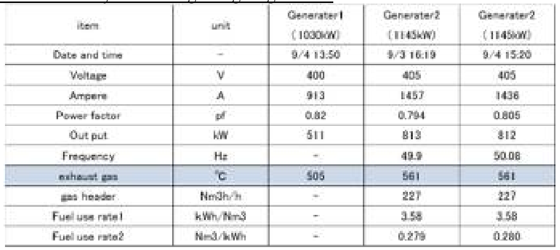
Table: 5-2 Chimney temperature record in boiler

time	Recording date 9/1					
	Boiler No.1			Boiler No.2		
	chimney	steam	water	Chimney	steam	water
3	220	9.0	48	212	8.5	45
4	215	8.5	47	215	8.5	42
5	212	8.0	45	213	9.0	45
6	210	9.0	45	212	9.0	43
7	220	8.5	43	210	8.5	45
8	215	9.0	43	215	8.0	40
9	212	8.5	42	215	8.0	42
10	210	8.5	42	213	8.5	45
Av	214	8.6	44	213	8.5	43

time	Recording date 9/2		
	Boiler No.1		
	Chimney	steam	water
7	215	8.0	45
8	212	9.0	45
9	213	8.5	42
10	215	8.5	47
11	215	9.0	45
12	212	8.0	42
13	215	8.0	42
14	212	7.5	45
Av	214	8.3	44

5-3. Heat recovery from gas engine generators.

Table 5-3 daily record on gas engine generator



item	unit	Generater1 (1030kW)	Generater2 (1145kW)	Generater2 (1145kW)
Date and time	–	9/4 13:50	9/3 16:19	9/4 15:20
Voltage	V	400	405	405
Ampere	A	913	1457	1436
Power factor	pf	0.82	0.794	0.805
Out put	kW	511	813	812
Frequency	Hz	–	49.9	50.08
exhaust gas	℃	505	561	561
gas header	Nm3h/h	–	227	227
Fuel use rate1	kWh/Nm3	–	3.58	3.58
Fuel use rate2	Nm3/kWh	–	0.279	0.280

◆ **Table 5-3** is shown the temperature of exhaust air from gas engine generators.

◆ Exhaust air temperature from gas engine generators is very high.
By their record generator No.1 is 505℃, and No.2 is 561℃。Therefore it is recommended to install the steam boiler by heat recovery type.
Off course, steam from them can be used in the factory.

◆ Heat recovery is shown as follows,
Theoretical air volume for boiler combustion: A0

Theoretical exhaust air volume for boiler combustion: Go
Those parameters are introduced “*Boie*” formula.

Ao=2.957×HL/10,000-3.91＝2.957×41,800++/1,0000-3.91＝10.57Nm3/m3
Go=3.763×HL/10,000-3.91＝3.763×41,800/10,000-3.91＝11.29Nm3/m3
Actual gas volume of exhaustion is below (G)
G=Go+（m-1）×Ao＝11.29+（2.0-1）×Ao＝11.29+（2.0-1）×1057＝32.43Nm3/m3

(1) Be able to recovery energy from Generator No.1
(Actual exhaust gas volume) x (electric power by generator) x (fuel consumption) x (specific energy of exhaust gas) x (temperature difference before and after
32.43×399×0.279×1.38×（505-200）＝1,519,508kJ/hr（363,518kcal/hr）
(2) Be able to recovery energy from Generator No.2
32.43×578×0.279×1.38×（561-200）＝2,605,345kJ/hr（623,288kcal/hr）
(1)+(2)＝1,519,508kJ/hr+2,605,345kJ/hr＝4,124,853kJ/hr（986,807kcal/hr）
For one year: operation efficiency=70%
4,124,853kJ/hr×0.7 ×24hr×300day/year/1000,000=20,789GJ/a

5-4 Thermal insulation for steam line

◆ There are many facilities without thermal insulation in boiler room and dyeing section; i.e. Steam pipes, valves and flange. Without thermal insulation protect heat losses, reducing boiler loading and electric power consumption.

◆ Even heat insulated have done, but already used quite long period, insulation material have worn out, it is better to change them periodically.

◆ Thermal loss without insulation on flanges and pipes at boiler site is shown in **Table 5-4**

Table 5-4 Steam loss from non-insulation or leaking valves

Valve size	Heat radiation from surface of steam valve		Valve	Amount of steam leak
	MJ/set・hr	MJ/set・day	sets	MJ/day
50A	16.1	386	5	1,931
80A	26.7	641	5	3,205
100A	34.8	836	5	4,178
150A	59.4	1,427	3	4,280
200A	87.2	2,092	3	6,275
total			21	19,869

◆ As 21-sets of valve are non-insulated, total 19,869MJ energy are diffused for one day. and annual amount as below,
19,869MJ/day×300day/year/1,000=5961GJ/year

5-5 Steam trap maintenance

Steam traps are installed at the end of steam line to prevent loosing energy. Steam traps have some kinds to matching for its purpose. However steam traps are running always with main facilities and those are not looked after properly. Supposing non maintenance for steam traps, steam leaking should be happened. And caused by leaking, energy loosing will be increased seriously.

◆ There are two reasons for steam leaking from steam traps.
1st reason is damaged steam trap itself without maintenance,
2nd reason is that some steam is splashed out with condensed water by mechanical reasons.

If steam amount is quite much, in that case it must change, because traps' construction or size is not suitable in steam facility.
By the reasons of non-maintenance, leaked steam amount is shown in **Table 5-5**

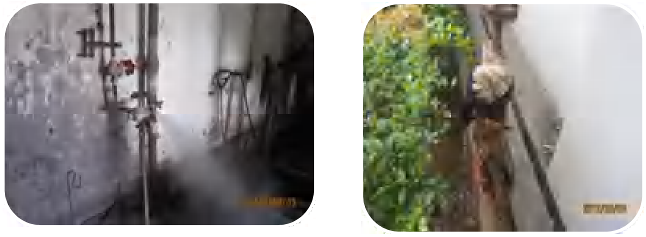
Table 5-5 Steam loosing amount depending on leaking condition

Item	Amount of lost steam			No of traps	Total amount
	kg/hr/set	kg/day/set	MJ/day/set	sets	MJ/day
1. leaks out a little__	4	96	263	5	1,314
2. leaks out a middle	7	168	460	5	2,300
3. leaks out a lot___	15	360	986	10	9,857
Total				20	13,471

- ◆ One sample is shown above **Table**.**5-5** Supposing 20 pieces traps are damaged, energy loosing is 13,471MJ/day. Otherwise, steam lost in amount is13,471MJ/day×300day/year/1,000=4,041GJ/year
- ◆ Some pictures are taken in LFL as follows,

main pipe condence extraction

From dyeing machine



Main pipe

From condensed pipe

Figure 5-1 Condensed and steam leaking in many places

5-6 Improvement of boiler efficiency

- ◆ LFL has 3boilers and they have used gas for fuels. Only one boiler (No.3) has gas and water flow meter. We measured both flow meters promptly. Data is shown **Table** 4-18.
- ◆ The boiler efficiency of No.3 is 79%, and it is not bad, but conductivity and hardness of boiler water are quite higher, boiler inside should be contained with some scale we have suspected.
- ◆ To improve the boiler water management, boiler efficiency should be improved more less 3%.

Steam evaporation weight: 4.57m^3
Gas consumption per hour: 360m^3
Specific Enthalpy per kg-steam: 2,768kJ=661kcal (under 8 bar),
Specific Enthalpy per kg-water:167kJ=40kcal(40℃ water)
Gas combustion energy per m^3: 41,800kJ=10,000kcal
Moment boiler efficiency＝
4,570kg/h×(2768kJ/kg-167kJ/kg)/(360m^3/h×41,800kJ/m^3)×100=79%
In case of boiler efficiency improved 79%⇒81%
358m^3/hr-（358m^3/h/81%×79%）=9m^3/hr（9m^3/hr×41,800kJ /m^3＝376.200kJ/hr
376.200kJ/hr×24hr×300day/year/1,000,000=2,709GJ/year

Table 5-6 Boiler No.3 efficiency measurement

Measuring date 5th.Sept. 17:40～17：50

time	Gas consumption		steam
	m3/mim	m3/hr	ton/hr
17:41	6.1	-	-
17:42	5.8	-	-
17:43	5.9	-	-
17:44	6.1	-	-
17:45	6.0	-	-
17:46	6.0	-	-
17:47	5.8	-	-
17:48	6.1	-	-
17:49	5.9	-	-
17:50	6.0	-	-
total	59.7	358	4.57
10 mins.	5.97m3/min		Water flow

Table 5-7 Measurement of boiler supply and internal water condition
Measuring date 5th .Sept. 10:00

		Water Softener (Ion exchange)		Boiler Water
		Inlet	Outlet	
Boiler 1	Temp	30.7	30.8	
	Hardness	5 0～100	0～10	0～10
	μ s	224	233	1,792
Boiler 2	Temp	30.7	30.8	
	Hardness	5 0～100	0～10	0～10
	μ s	224	233	4,924
Boiler 3	Temp	30.5	30.8	-
	Hardness	5 0～100	0～10	10
	μ s	234	281	9,105

Blow down frequency: every 1min/hour

5-7 Electric power saving in wastewater treatment plant (WTP)

- WTP is adopted in activated sludge method, and 2 sets of air blower are supplied air for aerobic bacteria. Those blower motors have not variable speed systems.
- For activated sludge system, dissolved oxygen amount (DO) is very important parameter to keep condition steady always.
  By our DO measurement, oxygen concentration has been maintained within 3.1 to 6.2 ppm as shown in **Tabl**e **5-8.**
  By the regulation of BGD, DO value must be more than 5.0 ppm, but excess than 5.5ppm is meaning of waste of electric power.
- To reduce air supply to aeration tank, it is some methods. (1) Cut air supply to close the air valve. (2) Change pulley diameter to slow down blower rotation. (3) Install inverter controller to change rotation speed. The system (3) can be reduced electric power.

Table 5-8　DO condition in WTP (LFL)

Item	DO ppm	Temp ℃
Inlet drain	0.73	42
Equalization tank		
Reach chamber		
Primary setting tank (Fresh mixer tank)	3.1	40.4
Primary setting tank	3.5	
Drain		
Aeration tank	6.0	35.4
Drain		
Secondary setting tank	6.2	35.9
Recover tank		
Filter		
Outlet drain		

Table 5-9 WTP condition

Parameter	In put	Out put
BOD	82	48.6
COD	290	128
TDS	4210	1760
DO	0.0	4.6
pH	10.67	7.51

Copy from BGD the authority report

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6. Energy conservation in utility section (Grameen knit wear Ltd.)

6-1. Efficiency improvement in boilers' load

- For boiler operation, load factor is very important.
  In case of lower load in boiler, as heat radiation rate become higher, so total energy efficiency will be going down. The other hand, boiler load is higher, exhaust air contain more sensible heat, fuel energy may diaper to atmosphere, therefore total efficiency will be go down also.
  Therefore boiler operation is needed reasonable load rate, so as 60% to 80% of full capacity is recommended shown as **Figure 4-7**

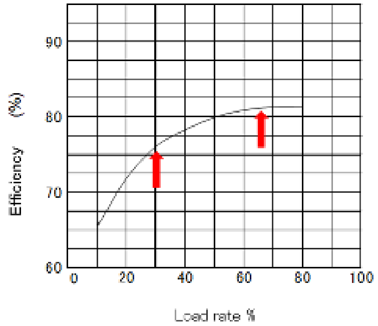


Figure: 6-1 boiler efficiency and load relation

- The speculation load of Boiler No.2 is 4,535kg/hour; however actual operation is only 1,400kg/hour, consequently is not well in efficiency.
  From Figures, boiler efficient rate is 76% automatically.
- Our recommendation is that three boilers are reduced to two boilers operation (Boiler No.3 is stop). Therefore efficiency of　boiler No.2 is improved as mentioned below,
  Boiler No.2 load rate; 5,630kg/（3,630kg+4,535kg）x 100=68%
  Boiler No.2 efficiency; 81% from Figure (5% up)
  By calculation, following energy saving can be achieved;
  (1400kg/hr-(1400kg/hr/0.81×0.76)×10h (No. 3 boiler operation hours)×300day/a/1000
  =259ton-steam/a
  259ton-steam/a×2,768MJ/ton/1,000=717GJ/a

Table 6-1: Boiler list in GKL

item	unit	boiler No.1	boiler No.2	boiler No.3	boiler No.4
Manufacture year:	-	1998	1998	2003	2006
Brand name	-	COCHRAN	COCHRAN	COCHRAN	COCHRAN
Origin	-	UK	UK	UK	UK
Types	-	Fire tube	Fire tube	Fire tube: Diesel	Fire tube: Diesel f
Evaporation capacity	kg/hr	3,630	4,535	1,500	5,000
Design pressure	bar	12	12	12	12
Working Pressure	bar	10	10	10	10
Fuel (Gas) Consumption	M3/hr Liter/hr	259	324	111	(353)
	M3/Day (Lt./month)	6,206	7,781	1,114	(3,528)
Remarks				Operation 10hrs/day	Standby for urgent (10hrs/month)

Table:6-2 Boiler condition in operation 12th Sept. (GKL)

item	unit	Boiler No.1	Boiler No.2	Boiler No3*1	Total
Steam Generating Capacity	**kg/hr**	**3,630**	**4,535**	**1,500**	**9,665**
Working Pressure (speculation)	**bar**	**10**	**10**	**10**	**-**
Feed water quantity	**kg/hr**	**3300**	**1400**	**930**	**5,630**
Steam pressure (actual)	**bar**	**7.7～8.3**	**7.7～8.3**	**7.7～8.3**	**-**
Load rate	**%**	**91**	**31**	**62**	**58**

*1: No.3 boiler is operated 10hrs/day, because it is specialized for garment factory

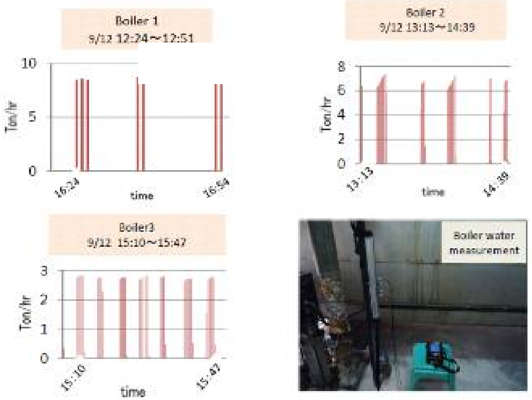


Figure 6-2 Boiler water supply condition & measurement

6-2. Thermal insulation for steam line

- ◆ There are many facilities without thermal insulation in boiler room and dyeing section; i.e. Steam pipes, valves and flange. Without thermal insulation protect heat losses, reducing boiler loading and electric power consumption.
- ◆ Even heat insulated have done, but already used quite long period, insulation material have worn out, it is better to change them periodically.
- ◆ Thermal loss without insulation on flanges and pipes at boiler site is shown in **Table 6-3**

Table 6-3 Steam loss from non-insulation or leaking valves

Valve size	Amount of steam diffusion		Valve	Steam leak amount
	MJ/set･hr	MJ/set･day	sets	MJ/day
50A	16.1	386	10	3,862
80A	26.7	641	5	3,205
100A	34.8	836	5	4,178
total			20	11,246

0.4MPa-steam: 2,738kJ/kg

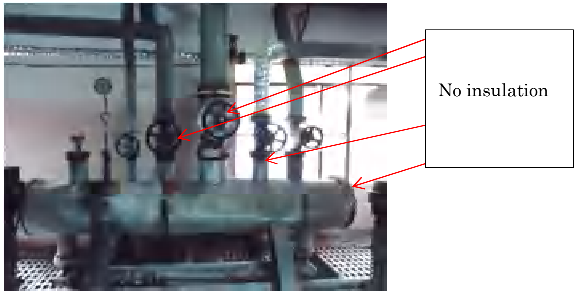


Figure 6-3 Steam header by boiler in GKL

- ◆ As **Table 6-3**, from 20 valves, 11,246MJ is lost in one day
- ◆ 11,246MJ/day×300day/year/1,000=3,374GJ/year

6-3 Steam trap maintenance

Steam traps are installed at the end of steam line to prevent loosing energy. Steam traps have some kinds to matching for its purpose. However steam traps are running always with main facilities and those are not looked after properly. Supposing non maintenance for steam traps, steam leaking should be happened. And caused by leaking, energy loosing will be increased seriously.

- ◆ There are two reasons for steam leaking from steam traps.
  1st reason is damaged steam trap itself without maintenance,
  2nd reason is that some steam is splashed out with condensed water by mechanical reasons.
  If steam amount is quite much, in that case it must change, because traps' construction or size is not suitable in steam facility.
  By the reasons of non-maintenance, leaked steam amount is shown in **Table 6-4**

Table 6-4 Steam loosing amount depending on leaking condition

Item	Amount of lost steam			No of traps	Total amount
	kg/hr/set	kg/day/set	MJ/day/set	sets	MJ/day
1. leaks out a little__	4	96	263	3	789
2. leaks out a middle	7	168	460	2	920
3. leaks out a lot___	15	360	986	2	9,857
Total				7	3,680

- Supposing 7 pieces traps are damaged, energy loosing is 3,680MJ/day
- 3.680MJ/day (3,680MJ/day×300day/year/1,000=1,104GJ/year

6-4. Electric power saving in wastewater treatment plant (WTP)

- WTP is adopted in activated sludge method, and 2 sets of air blower are supplied air for aerobic bacteria. Those blower motors have not variable speed systems.
- For activated sludge system, dissolved oxygen amount (DO) is very important parameter to keep condition steady always.
  By our DO measurement, oxygen concentration has been maintained under 5ppm as shown in **Table 6-5.**
  By the regulation of BGD, DO value must be more than 5.0 ppm, but excess than 5.5ppm is meaning of waste of electric power.
  To reduce air supply to aeration tank, it is some methods. (1) Cut air supply to close the air valve. (2) Change pulley diameter to slow down blower rotation. (3) Install inverter controller to change rotation speed. The system (3) can be reduced electric power.

Table 6-5 WTP condition

Name	Parameter	Data
Water Tank	DO	0.08
	Temp	46.9
	pH	9.4
	Electric conductivity	4,549
Primary Tank	DO	0.16
	Temp	32.2
	pH	11.1
	Electric conductivity	2,140
Aeration Tank	DO	5.76
	Temp	31.4
	pH	8.1
	Electric conductivity	2,290
Secondary Tank	DO	3.6
	Temp	31
	pH	8.1
	Electric conductivity	3,000

- Electric power consumption is 35kWh total, all most 60% of consumption is occupied by air blowers. Therefore DO management is important, always check DO value, and adjust motor rotation, as reasonable condition.
- Plant layout is quite well designed, but activated sludge system is needed return sludge line and control return sludge amount.

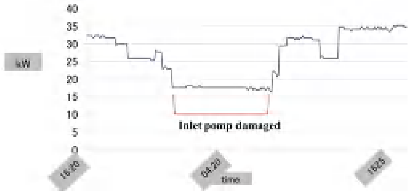


Figure 6-4 Electric power consumption at WTP (GKL)

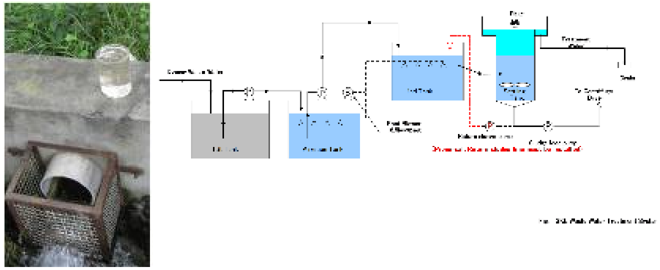


Figure 6-5 WTP in GKL

6-5. Steam condensate & warmed cooling water recovery

- In case of heat up substances, mainly latent heat in steam gives it function. After heating steam condensate is flush out from steam traps. Condensate has no latent heat, but still have sensible heat more less 100℃。
- Condensed drainage is not only useful for heat energy, but also water souse.
- The recovery system of condensed water is two ways. One is open system and other is closed one. Open system is going under atmosphere condition and closed system is under pressured condition.
- In case of open system, maximum temperature of condensed is 100℃, and investment is quite lower. On the other hand, closed system can be got condensed water in higher temperature. Therefore, closed system has advantage in the efficiency of recovering.
- In Grameen knit wear ltd, they have made condensed water pipeline to return boiler. But this pipeline has been mixed with cooling water, and finally they put some water before feed to boiler. The pipeline and water supply tank are shown following Figures.
- **The Biggest Question of this pipeline**
  (1) Boiler steam is used in dyeing & garment section, and steam is used under closed condition.
  (2) Wormed cooling water in 100% volume has been mixed to condensed water.
  (3) Temperature of lower received tank is 94℃、 however heed water tank temperature 60℃
  Total boiler supply volume is 5.6m^3 from **Table 6-2**
  Total calories for boiler supplied ; 5.6m^3 x 60℃=336Mcal
  Mixing ratio between condensed water and fresh water is needed formula as follows,

60℃ x 5.6m^3=336Mcal/hr. X; volume of condensed water,
Y; fresh water to feed upper supply tank
X + Y=5.6m^3, (94 x X)+ (30 xY)=336Mcal →X=2.6m^3, Y=3.0m^3

- **Boiler water is needed half amount from fresh water. Why??**
  Condensed water from dyeing machine: 3m^3 (because plenty condensed water leaking)
  It is estimation that warmed cooling water is going to WTP or outside drainage; it means warmed cooling water is not used at all. If warmed cooling water is mixed with condensed, condensed tank temperature go down to near 80℃。Off course, water volume is coming more.
  By calculation from **Table 4-8**, cooling water amount is 140m^3/day. (5.8m^3/hour)
  In common sense, condensed water and warmed cooling water come out same heat exchanger, but at outlet portion have two valves to separate each pipe. We have checked that both pipe jointed to one pipe as **figure 6-9** **Why why ????**
  Suspicion & improvement;
  (1) Condensed tank level controller is operated by manual operation; so plenty water flow out (over-flow). Therefore water lever control change to automatic.
  (2)One big valve which is front of condensed water tank, that is suspects to not fix properly.

If it is resolved that the reason of warmed cooling water is disappeared, some heat energy can be saved.
Saving amount: (80℃-30℃) x 3m3/hr x 24hr=3,600Mcal(15GJ)/day=5.5ton-steam(1800Tk)

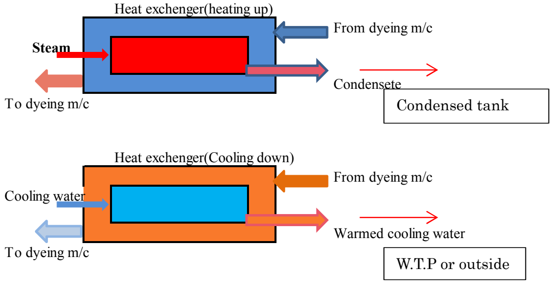


Figure 6-7 Model drawing heat exchanger & function

Table 6-6 Record of water tank for boiler feeding

		Steam Boiler		Feed water	
		Gas pressure	Steam pressure	Water level	Temp
		mbar	bar	Height(cm)	℃
9/10	8:00	80			
	9:00	80		90	60
	10:00	80	7.2	85	60
	11:00	80	7.3	80	60
	12:00	80	7.2	75	60
9/11	7;00	100	8.0	100	60
	8:00	100	7.9	95	60
	9:00	100	7.8	90	60
	10:00	100	8.0	85	60
	11:00	100	7.9	80	60
	12:00	100	7.7	75	60
9/12	7;00	100	8.3	100	60
	8:00	100	8.2	95	60
	9:00	100	8.0	90	60
	10:00	100	8.3	85	60
	11:00	100	8.2	80	60
	12:00	100	8.0	75	60

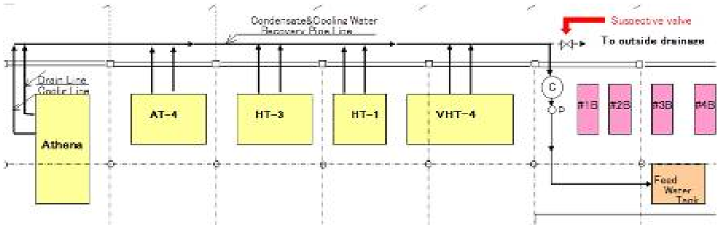


Figure 6-8 Condensate & cooling water pipeline in GKL

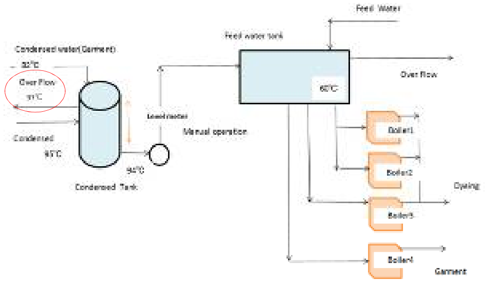


Figure 6-9 Condensate and feeding tank in GKL

6-6. Supply water for boiler

- Supply water for boiler must be soft one. As supplied water hardness and conductivity are higher than standard, so the scale is covered inside wall of boiler.
- Boiler No.1 and 2 are supplied quite harder water. Suspected some scale which is based on calcium is contained boiler inside. If scale thickness is 0.3mm, boiler fuel will need 1% more. Shown **figure 6-10.**
- If non maintenance or poor management for boiler water like proper blow down amount, you may suffer loss in one year as follows;
  5.6ton-steam/hr×24hr×300day/year×0.01＝403ton-steam/year、
  403ton-steam/year×2,768MJ/ton/1,000=1,115GJ/year

Table 6-6 boiler supply water quality 12th Sept. (GKL)

	Hardness	Electrical conductivity	Temp
		μ s	℃
Raw water	50	164	28
Softener water	0	168	28
Boiler water 1	0～10	9,425	-
Boiler water 2	0～10	6,934	-

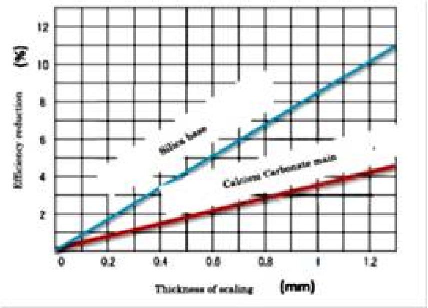


Figure 6-10 Boiler **e**ffect reduce by inside scaling

6-7.Energy saving in compressor

- Three compressors are installed, one of them is standby. Operated two are 55kW & 37kW electric powers. On-off setting is on-load 5.1br and off-loads 5.3br.
  Electric load rate is 67% to 69% and 63kW is power consumption.
- Energy saving will be reach to set up the pressure reduction. **(Table 6-8)**
- Most effective way is to check leaking portion in all air pipe and joint portions.
  In holyday, operate compressors, and stop compressors and check the receiver tank pressure down first. If pressure down is very quick, check all pipe line. (Pressure drop test)
  This is very simple way and no investment; therefore this test must carry on every year once.

Table 6-7 Compressor operation condition

		Ampere	Voltage	Output	Load rate
unit	kW	A	V	kW	%
Compressor No.1	55	64	400	38	69
Compressor No.2	37	42	400	25	67

Table 6-8 Compressor operation to save energy countermeasure

Counter measurement	Detail	Effect
Blow out pressure	Reduce 1bar	4～5%
Temperature management of inlet air	Temperature range reduction 30～10℃	3%
Check soaking pressure load	Reduce 200mmAq	1%

Figure 6-11 Air receiver in GKL

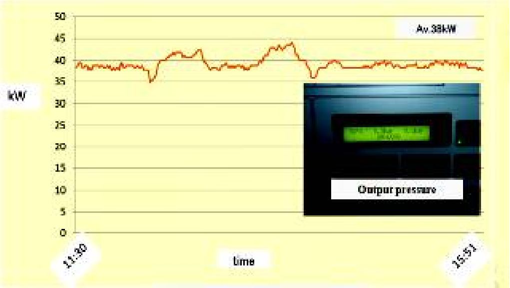


Figure 6-12 No.2 compressor power consume & pressure gauge

7. Conclusion

As above mentioned, our conclusion is as follows,

- Energy and water cost are very lower than other country. Particularly gas cost is surprised. Its cost is 1/12 of Japan, and 1/4 of Indonesia.1/5 of China. Companion with caloric base: shown in **Table7-1**

Table 7-1 Main energy sources cost comparison (Unit=¥ or Tk)

10Gcal (41.86GJ): Natural gas is 1000m3, Coal: 2,000kg, Heavy oil: 1,100liter

	Bangladesh	China	Indonesia	Japan
Natural gas	6,000	40,800	30,000	75,000
Coal (5000kcal/kg)		18,200	13,000	55,000
Heavy oil(9800kcal/lit)		40,000	40,000	68,000

Table 7-2 other sources cost

	Bangladesh	China	Indonesia	Japan
Electric power(kWh)	6.49	9.75	5.80	11.00
Industrial Water(m3)	22.43	11.70	14.17	25.00
GNP/person US$ (WHO 2010)	1,840	7,640	4,200	34,640

(GNP is different from personal income. Personal income is not same as **Table 7-2.**)

Under those circumstances, the big amount of investment to improve energy conservation is quite difficult. We can propose some idea to improvement, but those have limitation when they consider the payback period.

According to payback period, it is 5 to 7 years in the countries of developed, but in developing countries, it is common that the terms are more less 2 years.

Now we classify our proposals to three degrees; (1) lower or no investment payback less 0.5year, (2) payback period within 2 years, (3) payback period more than 2 years.

We don't propose highly amount investment to big revolution for changing the production and utility systems.

- We show some reference **Table 7-3 & 7-4** in another countries. Their energy cost quite higher than BGD, and already they have started energy saving countermeasures.
  BGD's textile or garment materials have power to compete other countries, however you mast set up strategy how to minimize energy consumption in each factories & country plan.

7-1.Proporsal for Landmark Fabric ltd

Table 7-1 Summary of the proposal from JTCC investigation at LFL

Item		Saving (GJ)/a	Saving/a Steam-ton	Saving/a	Invest	Payback (year)
				Unit=1,000 Tk		
Process Innovation						
4-1	Cooling water utilization	16,260	5,940	3,200	1,000	0.3
4-2	Heat exchanging from wastewater	14,922	5,460	3,000	10,000	3.3
4-3	Heat insulation to dyeing machine	1,285	471	256	500	2.0
Utility innovation						
5-1	Steam condensate recovery	16,308	5,969	3,240	1,000	0.3
5-2	Heat exchanger from chimney hot air	14,466	338,000 m3-gas	2,700	5,000	2.0
5-3	Steam boiler by exhaust hot air from generator	20,789	486,000 m3-gas	3,888	10,000	3.0
5-4	Thermal insulation for steam line	5,961	2,170	1,180	500	0.4
5-5	Steam trap maintenance	4,041	1,475	800	1,000	1.1
5-6	Boiler efficiency improve (management)	2,709	63,000 m3-gas	504	100*1	0.2
5-7	Wastewater treatment Electric saving					
	Total saving	96,741	**(38.5%)**	18,768	17,600	Av: 1.1

*1: boiler water quality measurement tools
Production: 15ton/day x 300days=4,500ton/a
Steam consumption: 306ton/day **(Table 5-1)** x 300=91,800ton-steam/a
Total energy: 91,800ton x 2,738MJ/ton-steam=251,348GJ
Saving rate by the innovation: 96,741GJ/251,348GJ x 100=**38.5%**

7-2. Proposal Grameen Knitwear ltd

Table 7-2 Summary of the proposal from JTCC investigation at GKL

Item		Saving (GJ)/a	Saving/a Steam-ton	Saving/a	Invest	Payback (year)
				Unit=1,000 Tk		
Process Innovation						
4-1	Cooling water utilization	11,000	4,020	2,187	1,000	0.5
4-2	Heat exchanging from wastewater	9,931	3,660	2,000	6,000	3.0
4-3	Heat insulation to dyeing machine	400	147	800	500	1.5
Utility innovation						
6-1	Steam boiler efficiency by less load	717	252	137	0	0
6-2	Thermal insulation for steam line	3,374	1,243	676	500	1.3
6-3	Steam trap maintenance	1,104	408	222	500	2.5
6-5	Steam condensate for boiler water	4,500	1,650	898	0	0
6-6	Boiler water management	1,209	445	242	100*2	0.4
6-4	Wastewater treatment Electric saving					
6-7	Electric power saving for compressor					
	Total saving amount	32,235	**(34.8%)**	6,442	8,600	Av: 1.3

*2: boiler water quality measurement tools
*Steam consumption: 113ton/day **(**from **Table 6-2)** x 300=33,800ton-steam/a
Total energy: 33,800ton x 2,738MJ/ton-steam=92,544GJ/a
Saving rate by the innovation: 32,235GJ/92,544GJ x 100=**34.8%**

7-3. comparison with other country (for reference)

Table 7-3 Indonesia Integrated factories (Spinning, Weaving & Dyeing total produced)

	Energy intensity GJ/day			Base line GJ/day			Saving Potential (%)		
factory	Elect.	Heat	Total	Elect.	Heat	Total	Elect.	Heat	Total
A	236	116	352	846	1,536	2,382	27.9	7.6	14.8
B	139	201	340	986	1,088	2,074	14.1	18.5	16.4
C	84	280	363	662	1,059	1,721	12.6	26.4	21.1

Table 7-4 Yarn Dyeing & Finishing Factory in China

	Steam consumption ton-steam (GJ)	Saving Potential energy (GJ/year)	Saving Potential (steam-ton)	Saving money 2100Tk/ton-steam
Preparation	14,197	9,059	3,318	
Dyeing facilities	66,050	44,230	16,982	
Total	80,247(219,716)	53,289(24%)	19,520(24%)	40,992,000/year

END

APPENDIX

1. Research Schedule at Bangladesh Dye-houses

Date	Position	Remarks	Date	Position	Remarks
8/31(Fri)	Dhaka arv.		9/8 (Sat)	Landmark	Additional data collection
9/1 (Sat)	Preparation		9/9 (Sun)	Grameen	Dyeing mc & Water pipe
9/2 (Sun)	W.S.T	1st Presentation.	9/10 (Mon)	Grameen	Dyeing mc Boiler & Steam line
9/3 (Mon)	Landmark	Dyeing mc & Water pip	9/11 (Tue)	Grameen	Finishing mc & wastewater
9/4 (Tue)	Landmark	Dyeing mc Boiler & Steam line	9/12 (Wed)	Grameen	Additional data collection
9/5 (Wed)	Landmark	Finishing mc & wastewater	9/13 (Thu)	W.S.T	3rd Presentation
9/6 (Thu)	W.S.T	2nd Presentation.	9/14 (Fri)	Dhaka Dep.	Transfer at BKK
9/7 (Fri)	Holiday		9/15 (Sat)	KIX	

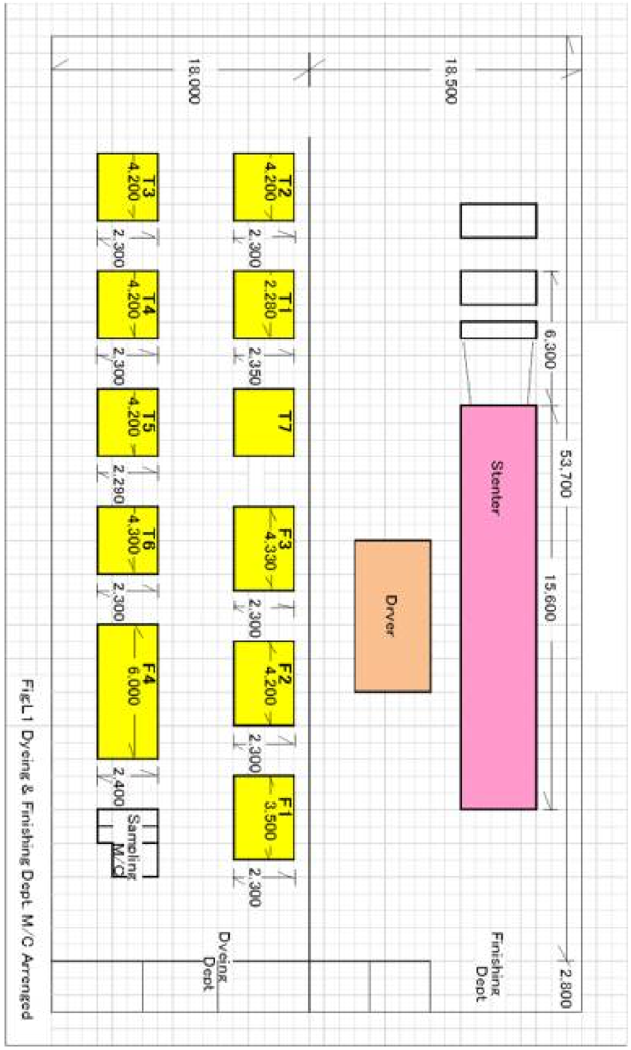
2. Factories Profiles

	Landmark Fabrics Ltd (Landmark Group)	Grameen Knitwear Ltd (Grameen Bank Complex)
Establishment	**2001**	**1998**
Number of working person	**D & F:200 (3-shifts) Garment:800 (day shift only)**	**D & F: 500 (3-shift) Garment: 2,500 (day shift only)**
Production	**Circular knit fabric :1 5tons/day (Max : Cotton, CVC 10tons each/day)**	**Circular knit fabric: 8tons/day (normal production: 7tons/day)**
Raw materials	**Cotton, CVC, Polyester 100% With some elastic yarn**	**Cotton, CVC with elastic yarn**
Production m/c	**Thies & Fong's HT dyeing m/c Dryer, Slitter, Stenter**	**Sclavos HT & AT dyeing m/c Dryer, Slitter, Stenter**
Utility	**3 Gas boiler, Diesel & Gas generators**	**4 Gas boiler, Diesel generators**
Water & Wastewater	3,600m3/day included other factories	800m3/day to dyeing WST:720m3/day

3. Main facilities in Landmark Fabric Ltd Dyeing & Finishing

M/C name	Capacity	Spec.	Character	Remarks
Thies No1.	150kg	1 flow	HT Round Jet	
Thies No2.	300kg	2 flows	HT Round Jet	
Thies No3, No.4	450kg	3 flows	HT Round Jet	Extensible 6 flows
Thies No.5,No6	800kg	4 flows	HT Round Jet	
Thies No.7	1200kg	6 flows	HT Round Jet	Under repair
Fong's No.1	600kg	3 flows	HT Round Jet	
Fong's No.2,No.3	800kg	4 flows	HT Round Jet	
Fong's No.4	1500kg	8 flows	HT Round Jet	
Splitter	10 tons/day	With retwist		Laser search
Padding Dewater	8 tons/day	Open width		Mangle type
Dryer	8 tons/day	Tube type	Net Conveyer	Gas burner
Stenter for Finish	8 tons/day	With Padder	Vertical 8 chambers	Gas burner
Stenter for Pre-set	10 tons/day	With Padder	Horizontal 10 chambers	Gas burner

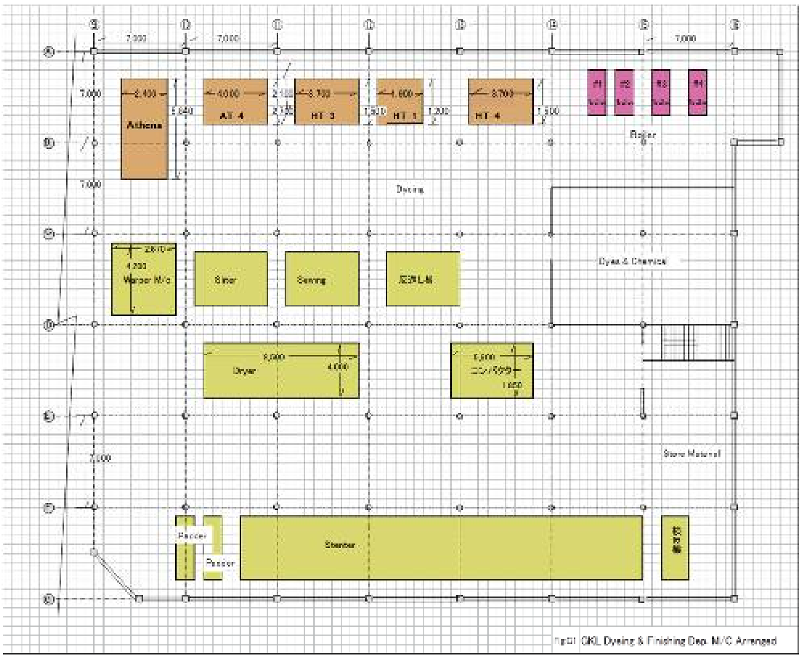
4. Dyeing and finishing facilities layout at Landmark Fabric Ltd



FigL1 Dyeing & Finishing Dept. M/C Arranged

5. Dyeing machines profile in Landmark Fabric Ltd

6. Dyeing and finishing layout at Grameen knitwear Ltd



7. Dyeing machines profile in Grameen knitwear Ltd

ATHENA	AT-4	HT-3	HT-1	HT-4
1000kg	540kg	720kg	180kg	720kg
Jet HT	Jet AT	Jet-HT	Jet-HT	Jet-HT
CVC/PET/C100	Cotton only	CVC/PET/C100	CVC/PET/C100	CVC/PET/C100

8. Investigation planning for each facility in dyeing & finishing

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Dyeing m/c	1	Electric Power consumtion	E.Power meter		Select the biggest capacity m/c
	2	Feeding water volume	Visual inspection	Prompt	Check to progrum data
	3	Feeding water volume for cooling	Ultrasonic flow meter		Compereing with Progrum chart
	4	Cooling water Temperature	Thermistor thermometer	Prompt	
	5	Feeding water temperature for dye bath	Thermistor thermometer	Prompt	
	6	Drain water temperature	Thermocouple thermometer		
	7	Jet m/c wall temperature	Radiation thermometer	Prompt	Record both dyeing and surface
	8	Drain water analize	pH & Conductivity meter	Prompt	Rinsing water after dyeing
	9	Fabric weight in dyeing	Visual inspection	Prompt	Possibly sampling

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Dryer	1	Water content before drying	Balance	Prompt	
	2	Operatin speed	tachometer	Prompt	Compering with m/c indicator
	3	Temperature (PS & PV)	Visual inspection	Prompt	
	4	Dryer wall temperature	Radiation thermometer	Prompt	Compering with m/c indicator
	5	Air volume from exhaust duct	Anemometer	Prompt	Must be under 50℃
	6	RPM in exhaust fan	Visual inspection	Prompt	Must check any alteration by condition
	7	Exhaust fan power consumtion	Visual inspection & Clamp	Prompt	Must check any alteration by condition
	8	Hot air temperature from exhaust duct	Thermistor thermometer	Prompt	Permission to make hole to chimney
	9	Fabric surface temp. at outlet	Radiation thermometer	Prompt	
	10	Inlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	11	Outlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	12	Fly dust filter condition	Visual inspection	Prompt	
	13	Gas consumption	Factory's meter & record	Copy	Check consumption by drying batch
	14	Electric Power consumtion	E.Power meter	Continuous logger	No needed in case of continuous operation

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Stenter	1	Electric Power consumtion	E.Power meter	Continuous logger	
	2	Water content before drying	Balance	Prompt	
	3	Operatin speed	tachometer	Prompt	Compering with m/c indicator
	4	Temperature (PS & PV)	Visual inspection	Prompt	
	5	Insulation wall temperature	Radiation thermometer	Prompt	Compering with m/c indicator
	6	Air volume from exhaust duct	Anemometer	Prompt	Must be under 50℃
	7	RPM in exhaust fan	Visual inspection	Prompt	Check fan & motor spec.
	8	Exhaust fan power consumtion	Visual inspection	Prompt	Must check any alteration by condition
	9	Hot air temperature from exhaust duct	Thermistor thermometer	Prompt	Permission to make hole to chimney
	10	Fabric surface temp. at outlet	Radiation thermometer	Prompt	In case for drying
	11	Inlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	12	Outlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	13	Gas consumption	Factory's meter & record	Copy	Check consumption by drying batch
	13	Fly dust filter condition	Visual inspection	Prompt	

9. Investigation planning for each facility in Utility

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Boiler	1	Steam consumption (water supply)・Pressure	Factory's meter Visual inspection	day average	Copies of factory'srecords
	2	Blow loss・Time・Volume	Stopwatch	Prompt	refer factory data in past.
	3	Blow water quality	pH & Conductivity meter	Prompt	Measurement by beaker after cool down to collected water
	4	Fuel consumption	Factory's daily record for boiler	Copy	
	5	Feed water temperature	Thermocouple thermometer	Continuous logger	
	6	Condensed water temperature	Same as above	Continuity	Balance between the amount of water
	7	Steam trap	Visual inspection	Prompt	steam leak etc.
	8	Boiler equipment	Factory's electricity meter or clamp meter	Prompt	Gas compressor exhaust fan water pump each other – (individual)
	9	Boiler feed water quality	Simple hardness kit & conductivity meter	Prompt	
	10	Exhaust gas temperature (inlet and outlet)	Thermistor thermometer	Prompt	Presence or absence of air heater and economizer
	11	Fuel calorific value	Gas supplier's data	Copy	
	12	Amount of supplied soft water	Ultrasonic flow meter	Continuous logger	Check in the amount of condensed water to boiler

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Water supply and wastewater	1	Electricity consumption of Waste water treatment equipment	Factory 's Electricity meter or clamp meter	Prompt / day average	each blower・pump・agitator etc. (required each equipment)
	2	Water processing equipment	Factory's Electricity meter or clamp meter	Prompt / day average	
	3	Water hardness	Chemical drop testing	Prompt	
	4	Quantity of supply water	Factory's Meter & record	Copy	
	5	Feed pump (electricity)	Clamp	Prompt	
	6	DO levels of the wastewater treatment equipment	DO meter	Prompt	
	7	Inlet temperature of wastewater treatment	Thermocouple meter	Continuous logger	
	8	Volume of wastewater	Factory's meter	Record copy	
	9	Inlet and outlet water quality of waste water treatment	Data of factory's record the	Copy	BOD / COD / T-N / SS / MLSS etc.

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Compressor	1	Over all capacity	Current meter, stopwatch, inspection	Individual check	ON-off timing
	2	Air leak	Listening	Checked at opening time	Consider on site
Piping	1	Heat insulation	Radiation thermometer	Prompt	Including the steam header
Receiving and distribution	1	Power Consumption	Factory's meter	Continuity	If you have a large receiving point is the location of the MAX
	2	Power factor	Check sites meter & record	Prompt	
	3	Maximum electric power	Check Factory's daily record	Copy	
Factory environment	1	Lighting condition	Light meter	Prompt	Each process
	2	Temperature and humidity	Thermo-hygrometer	Prompt / day average	Knitting process

To check each motor control (Inverter or manual)

10. Peoples who have supported JTCC works