CLEAN DEVELOPMENT MECHANISM
SMALL-SCALE PROGRAMME OF ACTIVITIES DESIGN DOCUMENT FORM
(CDM-SSC-PoA-DD) Version 01

CONTENTS

NOTE:

(i) This form is for the submission of a CDM PoA whose CPAs apply a small scale approved methodology.

(ii) At the time of requesting registration this form must be accompanied by a CDM-SSC-CPA-DD form that has been specified for the proposed PoA, as well as by one completed CDM-SSC-CPA-DD (using a real case).

SECTION A. General description of small-scale programme of activities (PoA)

A.1 Title of the small-scale programme of activities (PoA):

Punjab State Electricity Board : High Voltage Distribution System for Agricultural consumers in the Rural Areas of the Punjab.
Version: 01
Date: 29/1/2009

A.2. Description of the small-scale programme of activities (PoA):

General operating and implementing framework of PoA

The Punjab State Electricity Board (PSEB) is statutory body fully owned by the Government of Punjab with an autonomous status. PSEB is responsible for electricity generation, transmission and distribution of power in the state of Punjab. The PSEB generates its own power as well as gets its share of power from Bhakra Beas Management Board (BBMB) which operates several hydroelectric plants in the Northern region of the country. Further, PSEB also purchases power from the Central Sector Power Projects.

PSEB is currently faced with an energy deficit of over 15 percent, which is met by a combination of dynamic load shedding and power purchase from various IPPs (Independent Power Plants) including, Malana I,NTPC,NHPC,NPCIL, ,Damodar Valley Corporation, etc. According to PSEB's business plan[1], demand is expected to increase in the 11th plan period from 27,900 GWh in 2007 to 40,800 GWh by 2012, imposing increasing strain on PSEB.

PSEB's Transmission & Distribution (T&D) losses are currently reported to be around 25 percent. The existing distribution system for the agricultural consumers consists of feeders working at low voltage 3-phase 400 V. The 11 KV feeders are starting from the bus-bar located at the 66 KV grid sub-stations. Subsequently 11KV is stepped down , for use by a group of consumers ,by using 11KV/400 V distribution transformers (ratings 25 / 50 /63/100/200 KVA) to LV (Low Voltage that is 400 V).

The distribution system is divided in 5 Distribution zones (North, Central, South, West and Borders zones). Each Distribution Zone is further segregated into several Distribution circles.

As a project activity, in order to reduce the technical losses, PSEB proposes to replace the existing 3-phase 400V Low Voltage Distribution System (LVDS) feeding Agricultural Pumps (AP), with an 11-kV High Voltage Distribution System (HVDS) within the five distribution zones in Punjab.

In the year 2006-2007, PSEB delivered approximately 7,317 GWh to APs in rural areas. The foresaid project, in the state of Punjab, proposes to convert existing 950,000 AP consumers currently on LVDS to HVDS in two phases.

The Phase 1 covers 525,000 agricultural pumps (APs) consumers being fed by 3-phase 3 wire system (segregated feeders supplying exclusively to agriculture load).46 Details Project Reports (DPRs) have

[1] PSEB- Report on Business Plan- CARE Advisory, February 2007.

already been prepared for conversion of LVDS to HVDS for the foresaid AP consumers. Phase –II covers 4,25,000 AP consumers being fed by 3-phase 4 wire (desegregated feeders –Agriculture & Commercial load).

The implementation of 6 projects consisting of about 81,000 agricultural consumers of phase 1 started in October 2007. The 40 remaining projects in this Phase 1 will be fully implemented within a three-year period (completion by March 2010). Phase 2 will cover about 425,000 APs consumers and DPRs are under preparation. The implementation of all DPRs in Phase 2 is planned to be completed by March 2011.

Once fully commissioned the program will bring down the technical losses of the existing agriculture distribution system leading to an estimated saving of 1500 GWh per year from the 46 projects of Phase 1 only. List of 40 schemes including their name, location and REC identification code is attached as **Table 1, Annexure 4.**

The HVDS Programme financing has been secured from Rural Electrification Corporation (REC). The financing is sanctioned based on DPRs (Detailed Project Reports) prepared for each circle/division of PSEB and REC is providing a loan of 90% of the total investment.

Policy/measure or stated goal of the PoA

In line with the Planning Commission recommendations, PSEB has launched the present initiative to reduce technical losses in its distribution system[2] in order to increase the amount of available energy in the state and improve its cash flow. The initiative will not only increase the power availability by reducing electricity losses but also reduce load shedding requirements and need for power purchase from IPPs.

Distribution system conversions will reduce lines current by 27.5 times (11,000/400) and thus the technical energy losses induced by Joule effect (proportional to the square current) by around 800 times. Additional benefits that will accrue from the above initiative include:

- The energy saved could be used by additional consumers and used for future extensions.
- Improved voltage profile to AP consumers. The length of low voltage line will be limited to service line as transformers will be installed close to APs. The voltage drop will be reduced (especially during peak time) improving the voltage profile available to the pump sets and consequently lead to improvements in the life of AP motors
- Transformer failure resulting from overloading will become less frequent as the existing old transformers will be replaced by new ones which would match with the load requirements of a specific consumer.

Confirmation that the proposed PoA is a voluntary action by the coordinating/managing entity.

According to CEA's (Central Electricity Authority) recommendation, the State Governments would prepare a Five Year Plan with annual milestones to bring down the losses expeditiously. However, there is no law that obliges the state Governments or utilities to undertake the implementation of HVDS programme.

[2] PSEB- Report on Business Plan- CARE Advisory, February 2007

There are no mandatory directives to PSEB to implement HVDS programme. Thus the PoA is a voluntary initiative taken by PSEB to upgrade the distribution network, to ensure reliability in power supply to rural consumers and to save energy by reducing lines losses.

A.3. Coordinating/managing entity and participants of SSC-POA:

Coordinating or managing entity of the PoA as the entity which communicates with the Board.

PSEB is the programme promoter, implementing and operating entity through its five Distribution zones Departments i.e. West, Central, North, South and Borders zones. PSEB will be the coordinating and managing entity of the PoA. The International Bank for Reconstruction and Development (IBRD), as Trustee of its Carbon Funds (Trustee) would manage the communications with the CDM Executive Board, in close coordination with PSEB.

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Government of India	Punjab State Electricity Board	No
	International Bank for Reconstruction and Development as the Trustee of the Carbon Funds	Yes

This programme is part of PSEB plan to improve the efficiency of its distribution system. All the investments are also borne by PSEB . PSEB is the only project participant.

Each CPA falls under specific distribution divisions or subdivisions jurisdiction. The structure adopted for this PoA includes a managing and coordinating team at the PSEB Distribution Member office (The highest executing authority of PSEB).

Programme cells will be created at distribution zones which will coordinate with field units at each CPA level.

A.4. Technical description of the small-scale programme of activities:

The technology involved is voltage upgradation in the distribution lines from 400 V to 11,000 V. The AP consumers will be fed through HVDS (11,000 Volts), using existing poles, conductor and by installing small capacity dedicated Distribution Transformers (DT) at the delivery point to the AP consumers. Only the hardware and insulators suitable for 11 KV shall be replaced to withstand voltage stress and maintain clearances in compliance with the Indian Electricity Rules.

Under the proposed project activity PSEB will decommission a large number of existing high capacity transformers (25 to 200 KVA) and will install new 6.3 kVA, 10 kVA, 16 kVA and 25 kVA transformers depending upon the load requirements to feed individual AP consumers in different areas.

The resultant energy savings can be equated to reduction in the need for electricity generation at the grid level. The State of Punjab is fed by the integrated NEWNE (North, East, West, and North-East) Grid and as per the Central Electricity Authority (CEA)[3], Ministry of Power, Government of India, as on September 2008, per MWh of electricity saved in the NEWNE Grid about 0.80 tons of carbon dioxide emissions are saved to the atmosphere.

The saving in electricity through loss reduction and leading to lesser emissions to the environment will have a positive effect in the region in terms of socio-economic development and environmental gains in the northern region of India.

The revenue from the carbon credits that would accrue to PSEB under the Clean Development Mechanism of the Kyoto Protocol, will lead to reduction of the interest burden of the REC loan taken by PSEB to implement the project, thus making it financially attractive to implement it across the state.

The present CDM Program of Activity (POA) targets only technical loss reduction in the feeders and excludes the energy saving and emission reductions through reduction in distribution losses or replacement of inefficient Agri-Pumps by the efficient pumps

A.4.1. Location of the programme of activities:

The programme of activities will be implemented in the State of Punjab. Punjab is located at 31^0 0' North and 76^0 0' East.

The POA includes the 1st Phase of the PSEB plan .In the 1st phase, 46 projects have been prepared by PSEB covering around 525,000 agricultural consumers in rural areas (see Annex 4, Table 1 for details).

Phase 2 will cover the distribution system feeding other 425,000 APs consumers.

A.4.1.1. Host Party(ies):

India

A.4.1.2. Physical/ Geographical boundary:

The programme boundary comprises Distribution Circles included in the 5 distribution zones covering about 12,000 villages in all Punjab rural areas. Each CPA activity covers an identified area as presented in Figure 2 for the foreseen 46 programme activities under phase 1 of the Programme

[3] The Central Electricity Authority web site http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm)

The boundary of each small-scale CDM Programme Activity (CPA) includes a physical, geographical boundary of one or more PSEB Divisions Circles/sub-Divisions. The "Detailed Project Reports'' (DPR) for the 46 schemes under Phase 1 are available.

The list of the 46 CPAs is attached as Table 1, Annexure 4.

Figure 1 : Geographical location of the project

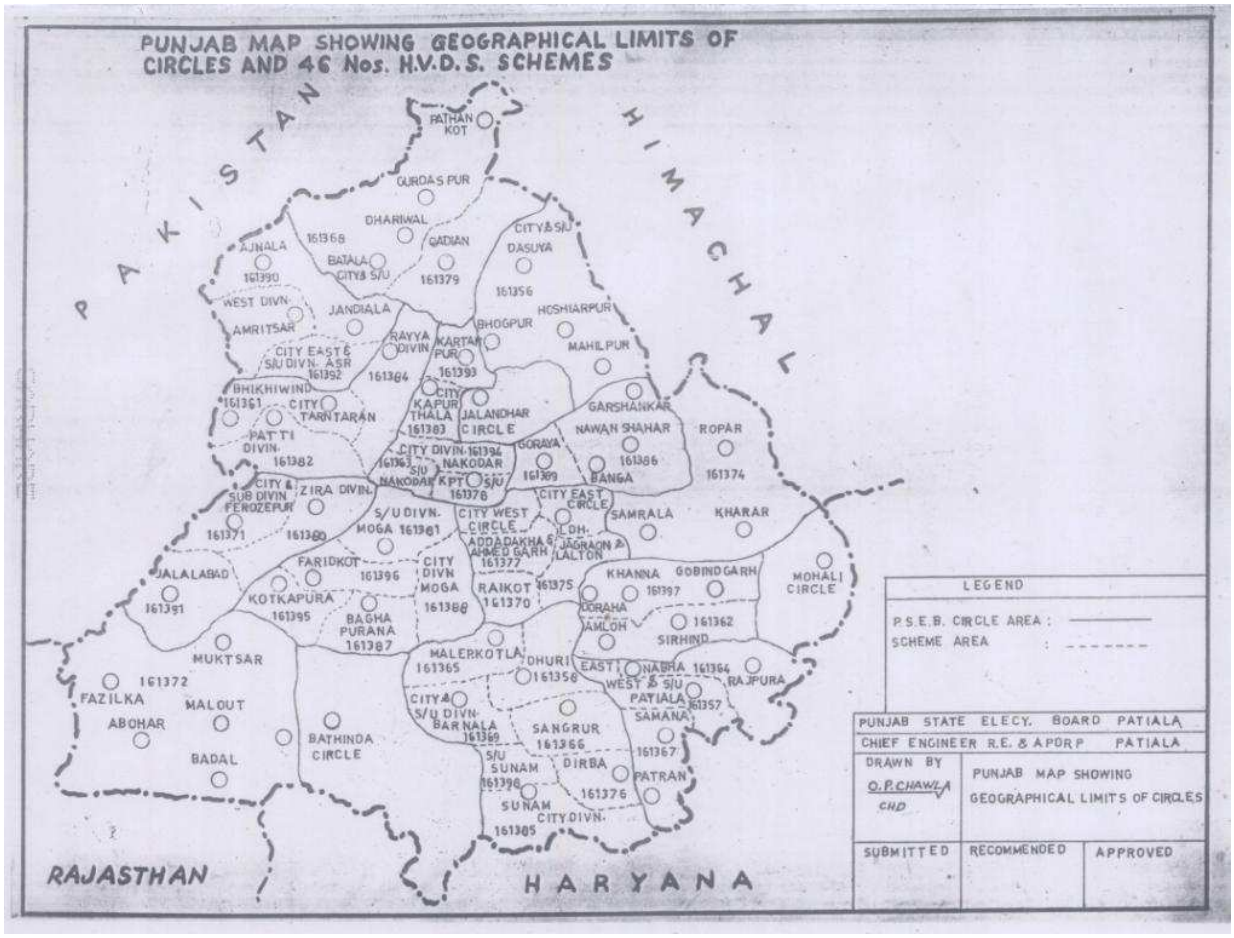

Figure 2: Geographical boundary of 46 CPA with identification code

A.4.2. Description of a typical small-scale CDM programme activity (CPA):

The Programme of Activities (PoA) objective is to reduce energy losses by upgrading LVDS to HVDS (400 V in the existing distribution system to 11,000V). The programme is targeting to improve the system efficiency. The existing 25 to 200 KVA distribution transformers will be replaced with 6.3 kVA, 10 kVA, 16 kVA and 25 kVA transformers according to the specific load requirements of each agriculture consumer or group of consumers.

A.4.2.1. Technology or measures to be employed by the SSC-CPA:

Technology / measures to be undertaken in a typical SSC-CPA include:

- Conversion of existing LVDS to HVDS using existing poles and conductors.
- Installing new transformers matching the load requirements of the agricultural consumers
- Dismantling existing transformers and unnecessary lines so that lines crossing is avoided

With the conversion of the LVDS to HVDS the technical line losses will reduce due to decrease in line current

A.4.2.2. Eligibility criteria for inclusion of a SSC-CPA in the PoA:

A SSC-CPA in this PoA is the conversion of LVDS to HVDS by upgrading the voltage from 400 V to 11,000 V. This will be the main criteria that any CPA shall meet to be eligible under the proposed PoA. Moreover, to be enrolled in the PoA, a CPA shall fulfil the following requirements:

- The CPA should be located in the State of Punjab in an area not covered by any other CPAs enrolled in this PoA or any PoA targeting LVDS to HVDS.
- The CPA is listed in table 1, Annexure 4 of this POA and has a REC assigned code
- The CPA involves conversion of LVDS to HVDS by upgrading the voltage from 400 V to 11,000 V.
- New 6.3 kVA, 10 kVA, 16 kVA and 25 kVA rating transformers will be installed for each AP consumer and existing 25-200 KVA rating transformers will be dismantled and handled in an environmentally sound manner.
- The cumulated energy savings resulting from the CPA should be equal or lower than 60 GWh per year.

A.4.3. Description of how the anthropogenic emissions of GHG by sources are reduced by a SSC-CPA below those that would have occurred in the absence of the registered PoA (assessment and demonstration of additionality):

The proposed PoA is a voluntary coordinated action

PSEB has embarked on a power sector reform which includes the reduction of energy wastage for non profitable agriculture sector consumers especially in the rural areas, by changing LVDS to HVDS, introduction of metering system for energy accounting, and infrastructure development. The current project activity is not part of any policy mandated as regulation.

The HVDS program's initiative of the PSEB seeks to increase power availability, reduce both load shedding requirements and the amount of relatively expensive power that will have to be purchased from IPPs and improve the financial viability of PSEB operations.

There are no mandatory directives or legal obligations for PSEB to implementing the HVDS programme. Thus the PoA is a voluntary initiative taken by PSEB to upgrade the distribution network, to ensure reliability in power supply to rural consumers and to save energy by reducing lines losses.

Thus the proposed PoA is a voluntary coordinated action .

If the PoA is implementing a voluntary coordinated action, it would not be implemented in the absence of the PoA;

As per Punjab Government notification power in agriculture sector is free to farmers and utilities are partially compensated for free power supply. The electricity tariff for the agricultural sector is set at Rs 2.40/KWh and is received by PSEB as tariff compensation from Punjab Government whereas the average cost of power delivery in the State of Punjab is approximately Rs 3.40/KWh [4]. Further, PSEB is conscious of revenue loss incurred due to technical losses in the agriculture sector .Thus LVDS and the

[4] PSEB- Report on Business Plan- CARE Advisory, February 2007

supply to agricultural consumers is a loss-making proposition for PSEB and CDM revenue will be used to bridge the revenue loss gap.

In absence of POA, business-as-usual investments in PSEB will continue to be prioritized on maintaining the LVDS systems in rural areas and not on conversion of LVDS to HVDS. More likely, technical losses and corresponding GHG emissions would increase as the existing systems degrade and the demand keeps on increasing. Typical O&M (operation & maintenance) practices will maintain systems and equipment as they are, and replace them with similar equipment when required. Thus the distribution performance will remain at the same level or worsen in future without the present project activity.

Without POA, more coal or other fuel input would be required to deliver any incremental increase in service and to fulfill the increasing demand for electricity.

CDM brings additional revenues stream that motivates PSEB to undertake the POA. CDM revenues will reduce interest burden on loans taken by PSEB from REC to implement the POA and also reduce risks of insufficient cash flow to be generated by the project for loans reimbursement. Without CDM, the implementation of such large scale initiative will be delayed or not implemented .

If the PoA is implementing a mandatory policy/regulation, this would/is not enforced;

Not applicable. The proposed PoA is not a mandatory policy or regulation.

If mandatory a policy/regulation is enforced, the PoA will lead to a greater level of enforcement of the existing mandatory policy/regulation.

Not applicable.

Project contribution to sustainable development

As per the India's targets, the project contributes to sustainable development for the well-being of the country in terms of environment, socio-economic, technology, and economy. Following are the sustainable development benefits for India:

Economic well-being:

The Government of Punjab has made electricity free for agricultural purposes. PSEB is partially compensated by Government on power consumed by the agriculture sector. CDM revenues will foster the POA implementation capacity of PSEB, thus augmenting availability of additional power in the state. The availability of the additional power would lead to economic development in the state thus fostering the growth in various sectors of the economy.

Environmental well-being: As a result of energy savings on account of technical loss reductions in the distribution of power, the POA leads to equivalent reduction in the power generation at the grid level. At the Northern grid level, wherein the power generation is a mix of hydro and fossil fuel, it leads to reduction of carbon dioxide (a Green House Gas) emissions.

No other negative impacts are expected from the project. Further, no Poly Chlorinated Biphenyls (PCB) are found in the transformers.

Social well-being: The POA will lead to avenues of direct and indirect employment during the implementation phase. The additional power made available in the state will help in improving the quality of life of the citizens and poverty alleviation, thus fostering social well being.

Technological well-being: The technology is well proven and standardized. There are no inherent risks in implementation of the technology. The POA once implemented would showcase to other utilities the viability of converting LVDS to HVDS to reduce technical losses, thus encouraging replication.

A.4.4. Operational, management and monitoring plan for the programme of activities (PoA):

A.4.4.1. Operational and management plan:

A record keeping system for each CPA under the PoA

Each CPA will be maintained as a separate file with the following information:

- The CPA file will include the data collection, collation and validation responsibilities, and all technical information so as to minimize data errors along with data / records & retention rules.

- Information will flow from the ground team at CPAs level, formed by divisions and subdivisions, to distribution zones and be conveyed to the coordinating and managing team at PSEB head office.

- The organizational structure of the PoA is composed of 3 hierarchic levels: the coordinating and managing team at PSEB head office, Zone CDM Cells at each distribution zone and CDM units at operation divisions/subdivisions level.

- Data will be checked at each step of the hierarchical chain and transmitted to the upper level with a short report on data validity and any relevant information on errors and how they were corrected.

- The Detailed Project Report (DPR) containing the reference and the physical data of each feeder, transformer, length of lines, sub-station and connected pumps within the CPA boundaries. 46 DPRs (6 schemes are under revision currently) are already developed by PSEB under Phase 1 and would be made available to the Validator .

- The baseline data for energy and demand. Each CPA has baseline defined based on the estimated technical losses using the standardized formula for the POA activity within the project boundaries.

- The supporting documentation required including: energy records, calculation spreadsheets, meters calibration certificate, etc.

- The newspapers communication and any stakeholder's comments received related to the area covered by the CPA

Note : PSEB has daily feeder-wise records of the energy consumption since 2003. The records are kept in hard copies at the sub-station level. Monthly reports are submitted to the division in hard copies.

For each CPA, loads and energy sent out records will be kept in electronic version and hard copies.

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 locations and boundary of all CPAs will have a unique identification code as per Rural Electrification Company (REC) code provided to 46 DPRs. The list of all the feeders will be provided in a unique list including the sub-stations reference and localisation. This list will be updated with the reference of each CPA enrolled in the PoA. The up-dated list of feeders will be included in the CPA documentation and made available for validation and verification by DOE.

Moreover, this HVDS initiative is a first of its kind in the state of Punjab. There is no such activity registered as a CDM project. No other organization in Punjab is undertaking such an initiative in the rural areas in Punjab.

Thus considering the foresaid, there is no possibility of double counting CPAs under the proposed PoA (see Table 1, Annexure 4 for the list of CPAs sanctioned by REC).

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

As per the Guidance for determining the occurrence of de-bundling under a programme of activities (PoA)[5]:

For the HVDS programme , PSEB is the only organization mandated to carry out transmission and distribution projects in Punjab. Power generation is liberalized, but transmission and distribution is mandated for PSEB only. No other project or PoA has been developed /implemented in the same sectoral scope in the state of Punjab.

There is: (i) no registered small-scale CPA of a PoA, (ii) no application to register another small-scale CPA of a PoA or (iii) no other registered CDM project activity in Punjab using HVDS to supply AP consumers in rural areas.

Thus, the SSC-CPA included in the PoA is not a de-bundled component of another CDM programme activity or CDM project activity.

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

The POA and each CPA under the project activity are operated/managed by PSEB .The distribution divisions and subdivisions of PSEB will operate all the CPAs as part of POA as integrated entities of PSEB.

[5] EB 33, Annex 21.

The POA is decided at PSEB Board level and implemented at the CPA levels from the financing made available by REC.

Each CPA has been trained in management and implementation of the CDM activities as per the POA and mandated to maintain data/information related to each CPA as per requirements of POA. The implementation of the Operating and Monitoring Plan for each CPA is responsibility of the CPA in-charge concerned.

A.4.4.2. Monitoring plan:

>> The following information shall be provided here:

(i) Description of the proposed statistically sound sampling method/procedure to be used by DOEs for verification of the amount of reductions of anthropogenic emissions by sources or removals by sinks of greenhouse gases achieved by CPAs under the PoA.

(ii) In case the coordinating/managing entity opts for a verification method that does not use sampling but verifies each CPA (whether in groups or not, with different or identical verification periods) a transparent system is to be defined and described that ensures that no double accounting occurs and that the status of verification can be determined anytime for each CPA;

The PSEB subdivisions/divisions/circles that are considered as CPAs under the POA currently are geographically located in rural areas of Punjab. Each of the Schemes (conversion of LVDS to HVDS in the rural areas) has a unique code, so that there is no double counting of the emission reductions.

The details of the number of feeders connected to agricultural pump sets (no. of connections) and the energy sent out will be recorded annually as per the table below.

Sr.No.	Name of Circle	Name of Schemes	REC Code*	No. Of Feeders	No. Of Connections	Energy Sent out (KWH)

* Rural Electrification Corporation – each loan application /scheme is coded.

As the project activity proposes to reduce the 'Technical Losses' through conversion of LVDS to HVDS, the 'Technical Losses' have been analytically calculated using the standard formulas derived and provided by the Rural Electrification Corporation (REC). The loss calculations have further been cross-checked in each of the circles through actual measurements. Details of the REC derived formulas and the calculations is enclosed as **Annexure-3.**

The cross-checked data would be made available to the DOE to assess the correctness & conservativeness of the calculated technical losses in terms of the percentage of energy sent out at each feeder , both for the baseline as well as the project activity case.

A.4.5. Public funding of the programme of activities (PoA):

There is no public funding available for the project activity.

SECTION B. Duration of the programme of activities (PoA)

B.1. Starting date of the programme of activities (PoA):

November 2007

B.2. Length of the programme of activities (PoA):

14 years

SECTION C. Environmental Analysis

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C.1. Please indicate the level at which environmental analysis as per requirements of the CDM modalities and procedures is undertaken. Justify the choice of level at which the environmental analysis is undertaken:

Environmental Analysis is done at PoA level.

The POA proposes to upgrade the voltage in the distribution network by converting the LVDS to a HVDS in 46 rural schemes .All the schemes included in each CPA are identical in nature and managed by single project entity PSEB. Therefore, the environmental analysis is proposed to be carried out at the PoA level.

This energy efficiency activity is not included in the Schedule of Ministry of Environment and Forests, Government of India as an activity that requires EIA or environmental clearance before its implementation.

C.2. Documentation on the analysis of the environmental impacts, including transboundary impacts:

There are no adverse effects to the environment. The program will have environmental benefits in terms of reduction in carbon dioxide emissions from the fossil fuel based power generation at the grid level as the reduction in the technical losses in the distribution system would translate to an equivalent lesser power generation at the fossil fuel based power stations.

C.3. Please state whether in accordance with the host Party laws/regulations, an environmental impact assessment is required for a typical CPA, included in the programme of activities (PoA),:

All CPAs are identical in the POA and as this activity is not included in the Schedule of Ministry of Environment and Forests as an activity that requires a environmental clearance before its implementation, EIA is not required for a typical CPA, included in this POA..

SECTION D. Stakeholders' comments

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D.1. Please indicate the level at which local stakeholder comments are invited. Justify the choice:

The stakeholder comments would be invited at the POA . Since CPAs are identical in the POA and there is a single POA managing identity PSEB, it is proposed that stakeholder comments are taken at the POA level.

The POA information would be placed in the public domain through the PSEB web site and stakeholders meeting would be held to explain the project details and modalities.
Comments would be received, recorded, replied and archived.

D.2. Brief description how comments by local stakeholders have been invited and compiled:

>>

D.3. Summary of the comments received:

>>

D.4. Report on how due account was taken of any comments received:

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SECTION E. Application of a baseline and monitoring methodology

E.1. Title and reference of the approved SSC baseline and monitoring methodology applied to a SSC-CPA included in the PoA:

Title: Approved Baseline and Monitoring Methodology for small-scale project activities for supply side energy efficiency improvements – transmission and distribution (AMS II.A).

Reference: Type II – energy efficiency improvement projects and category A - Supply side energy efficiency improvements – transmission and distribution, Version 09, EB 33.
UNFCCC website: http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

E.2. Justification of the choice of the methodology and why it is applicable to a SSC-CPA:

The category of the chosen methodology (AMS II.A) "comprises technologies or measures to improve the energy efficiency of an electricity network by up to the equivalent of 60 GWh_e per year".

The POA is the reduction in technical losses in a distribution system converting a three-phase 400-V distribution system to 11-kV High Voltage Distribution Systems (HVDS). POA's objective is to improve

the supply efficiency of existing distribution systems. The maximum output of a CPA in terms of energy savings is limited to 60 GWh.

The version 09 of the methodology AMS II A for small-scale projects activities includes activities under a PoA.

The CPA boundary is the physical, geographical boundary of the portion of the transmission and distribution system where the energy efficiency measures are implemented.

The CPA meets eligibility criteria for Type II energy efficiency improvement projects and category A – supply side energy efficiency improvements – transmission and distribution.

E.3. Description of the sources and gases included in the SSC-CPA boundary

The project boundary defined as per AMS –IIA is the physical & geographical area of each of the CPAs under the POA.

The POA aims at reduction of the technical losses as a result of conversion of LVDS to HVDS resulting in reduction in emission of CO2 equivalent to reduced power generation from the fossil based power plants.

E.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The alternatives to the POA includes

a) Business as usual scenario i.e the LVDS in the 46 divisions/schemes of PSEB and continue incurring the technical losses
b) Conversion of the LVDS to HVDS in the POA so as to achieve reduction in the technical losses and thus saving energy and corresponding lesser generation of fossil based power at the grid levels leading to reduction of carbon dioxide emissions (a GHG) – without CDM

As elaborated in section A.4.3 above , in Punjab the power is free for farmers (agriculture sector) and utilities are partially compensated for free power supply. Further, PSEB is conscious of revenue loss incurred due to technical losses in the agriculture sector. Thus LVDS and the supply to agricultural consumers is a loss-making proposition for PSEB and CDM revenue will be used to bridge the revenue loss gap.

In absence of POA, business-as-usual investments in PSEB will continue to be prioritized on maintaining the LVDS systems in rural areas and not on conversion of LVDS to HVDS. Typical O&M practices will maintain systems and equipment as they are, and replace them with similar equipment when required. Thus the distribution performance will remain at the same level or worsen in future without the present project activity.

Without POA, more coal or other fuel input would be required to deliver any incremental increase in service and to fulfill the increasing demand for electricity.

CDM brings additional revenues stream that motivates PSEB to undertake the POA. CDM revenues will reduce interest burden on loans taken by PSEB from REC to implement the POA and also reduce risks of insufficient cash flow to be generated by the project for loans reimbursement. Without CDM, the implementation of such large scale initiative will be delayed or not implemented.

Hence in absence of the POA , the baseline is defined as the LVDS system for the existing consumers.

E.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the SSC-CPA being included as registered PoA (assessment and demonstration of additionality of SSC-CPA): >>

E.5.1. Assessment and demonstration of additionality for a typical SSC-CPA:

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

The alternative scenarios have been identified in earlier section E.4.

"*Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis).*

Step 3: Barrier Analysis

Financing Barrier

The electricity tariff for the agricultural sector is Rs 2.40/KWh, received by PSEB as tariff compensation from Punjab Government (as per Punjab Government notification power in agriculture sector is free to farmers and utilities are partially compensated for free power supply) whereas the average cost of power delivery by PSEB in the State of Punjab is approximately Rs 3.40/KWh.Thus there is a revenue gap between the power delivery cost of PSEB and the compensation it receives from Punjab government. In order that PSEB remains a solvent company, the fore mentioned revenue gap is cross subsidized by the electricity tariff PSEB charges to its customers in non-agriculture sector as industrial, commercial etc.

Further, the revenue loss of PSEB in the agriculture sector gets increased by the 'technical losses' in the distribution system (LVDS).Thus, overall LVDS and the supply to agricultural consumers is a loss-making proposition for PSEB.

The POA , conversion of LVDS to HVDS leading to reduction of 'technical losses' and earning of carbon revenues is an attempt to partially reduce the 'cross subsidy' power supply gap between agriculture and non-agriculture sector being fed by PSEB in Punjab. Thus CDM revenue will be used to bridge the revenue loss gap.

In absence of POA, business-as-usual investments in PSEB will continue to be prioritized on maintaining the LVDS systems in rural areas and not on conversion of LVDS to HVDS. More likely, technical losses and corresponding GHG emissions would increase as the existing systems are degrading and the demand keeps on increasing. Typical O&M practices will maintain distribution systems and equipment as they are, and replace them with similar equipment when required. Thus the distribution performance will remain at the same level or worsen in future without the present project activity.

Without POA, more coal or other fuel input would be required to deliver any incremental increase in service and to fulfill the increasing demand for electricity.

CDM brings additional revenues stream that motivates PSEB to undertake the POA and move away from the maintaining the LVDS system.

Further, the POA (replacement of LVDS with HVDS) needs large investments that PSEB is getting financed from the loans from Rural Electricity Corporation (REC). The CDM revenues will reduce interest burden on loans taken by PSEB from REC to implement the POA and also reduce risks of insufficient cash flow to be generated by the project for loans reimbursement. Without CDM, the implementation of POA would face financial barrier in terms of the interest rates charged by REC on the investments and POA may not get implemented.

The POA is a 'first of its kind' activity being carried out in Punjab by the project proponent PSEB , which has the mandate to supply electricity in Punjab. Hence, the conversion of LVDS to HVDS is a not a common practice.

Considering the argument above, the POA /CPAs can be considered to be 'Additional'.

E.5.2. Key criteria and data for assessing additionality of a SSC-CPA:

Each CPA apart from meeting all the criteria for inclusion covered in the POA under A.4.2.2, would meet the following 'Additionality' criteria: Each CPA

a) is an identical activity implemented by PSEB and consistent with the current laws and regulations.

b) has at least following alternatives to the CPA

   1) carry on with the business as usual scenario i.e the LVDS in the CPA divisions/scheme of PSEB and continue incurring the technical losses

   2) conversion of the LVDS to HVDS in the CPA so as to achieve reduction in the technical losses and thus saving energy and corresponding lesser generation of fossil based power at the grid levels leading to reduction of carbon dioxide emissions (a GHG)

c) is contributing towards the revenue gap between the power delivery cost of PSEB and the compensation it receives from Punjab government.

d) is incurring 'technical losses' in the distribution system (LVDS)

e) involves conversion of LVDS to HVDS leading to reduction of 'technical losses'

f) is financed from the loans from Rural Electricity Corporation (REC), has a valid REC code assigned to it and a detailed project report is available.

E.6. Estimation of Emission reductions of a CPA:

As per provisions in AMS II.A, "for retrofit projects, the energy baseline is the technical loss of energy within the project boundary calculated as either: (a) the measured performance of the existing equipment; (b) the performance of the existing equipment as determined using a standard selected in accordance with paragraphs of the "general guidance".

The guidelines issued by Rural Electrification Corporation (REC) are being followed to calculate the losses in the distribution system.

The estimations of the emission reductions in each of the CPA will be based on data, as collected below. The 'Energy Saved' denoted in the table below, is in fact the 'technical loss' abated by conversion of LVDS to HVDS and arrived at using the REC formulas provided in section E.6.1.

Name of Scheme	REC Code	Energy Sent out (KWH)	Energy Saved (KWH)	ERs (tco2)	Gwh

E.6.1. Explanation of methodological choices, provided in the approved baseline and monitoring methodology applied, selected for a typical SSC-CPA:

Baseline energy due to technical losses

The baseline energy is the technical loss of energy within the project boundary calculated as per AMS II.A provisions. The energy supply to agricultural pumps is metered at every 11 kV feeder level across the Punjab State.

Connected load and other relevant details of the feeders are also available with PSEB and have been used for calculations of Baselines

The Detailed Project Reports (DPRs) for the CPAs/schemes contain the feeder-wise theoretical calculations for computing the 'Technical losses' with existing LVDS, as well as with proposed HVDS systems.

The guidelines followed for the calculation of Technical Losses are issued by REC (Government of India).

The baseline energy is therefore calculated as follows:

Equation 1: $E_{B,j} = E_{AP,j} * l_B$

$E_{B,j}$ Annual energy baseline in kWh for year "j". It represents the energy that would be lost in the absence of the proposed CPA.

$E_{AP,j}$ Annual input energy sent-out viz energy recorded at the sub-station in the project within the CPA boundary for year "j".

l_B Technical losses in percentage for each specific CPA in the baseline (LVDS). These are the average technical losses within the CPA boundary over the three last years.

Standard for Technical losses of energy calculation

The procedures for technical losses calculation are provided by REC. Technical losses are determined after HVDS project implementation. As per REC guidelines, the Power loss (kW_{loss}) is given by:

Equation 2: $KW_{loss} = 8.264 * 10^{-6} * P^2_{max} * R * L /(Df)^2$

Pmax Maximum demand in KVA
R Line resistance in Ohms/km. The value of resistance of various sizes of conductor at 60 °C is taken as per REC standards.
L Line length in km
Df Diversity factor which is the sum of individual maximum demand divided by the total max and demand of the sub station. The diversity factor is taken as 1.2 based on actual system parameters as per REC guidelines.

The annual energy loss (E_{loss}) is derived from power loss calculated above:

Equation 3: $E_{loss} = kW_{loss} * LLf * 8760 * 10^{-5}$

Where, $LLf = PF * LF^2 + 0.2 * LF$

LLf Loss load factor.
PF Power factor (0.8 as per REC guidelines).
LF Load factor which is the ratio between the average load and the maximum load. REC guidelines recommends LF equal to 0.3 based on actual system parameters.

The energy input is the metered consumption at feeders' level. Therefore, the technical losses coefficient can be calculated by dividing the annual energy loss by the annual energy sent out on each feeder.

E.6.2. Equations, including fixed parametric values, to be used for calculation of emission reductions of a SSC-CPA:

If I = Current; R = Resistance and L = Length of the conductor, V= Voltage in the distribution system, P = Power , Pf-= Power Factor , then

	Technical Losses	$= 3 I^2 RL$
	Technical Losses in Kilowatts	$= 3 I^2 RL \times 10^{-3}$
	P (Power in VA)	$= 3^{1/2}$ V x (in volt) x I (in amps) P = Watt/Pf (Pf – Power factor)
therefore	P (Power in KVA)	$= 3^{1/2}$ V x (in KV) x I (in amps) P = KW/Pf
therefore	I	$= P/ 3^{1/2} V$
therefore	$3 \times I^2 \times R \times L \times 10^{-3}$	$= 3 \times (P/ 3^{1/2} \times V)^2 \times R \times L \times 10^{-3}$ where P is in KVA

$= (P / V)^2 \times R \times L \times 10^{-3}$

$= P^2 \times R \times L \times (10^{-3} / V^2)$

V is in KV
R is in Ohms/Km
L is length in Km

Kilowatt Loss

KW Loss = $P^2 \times R \times L \times (10^{-3} / V^2)$

Kilowatt Loss for 0.400 KV

KW loss = $6.25 \times 10^{-3} \times (P^2 R L)$

where P is max. demand in KVA
V is voltage in KV
R is resistance in Ohms/Km
L is length in Km

Kilowatt Loss for 11 KV

KW loss = $0.008264 \times 10^{-3} \times (P^2 R L)$

where P is max. demand in KVA
V is voltage in KV
R is resistance in Ohms/Km
L is length in Km

Diversity factor is not being considered as the total hours of supply are 1920. Load Factor (LF) are not being considered as the losses are being calculated on each section of the Distribution transformers. Loss Load factor (LLF) is not considered because the power requirement in case of Agricultural is almost constant during the supply hours. Power factor for AP consumers is being taken as 0.88.

Annual Kilowatt hour Loss for 0.400 KV (LVDS)

KWh loss = $6.25 \times 10^{-3} (P^2 R L) \times 1920$

= $12 \times (P^2 R L)$

where P is max. demand in KVA
V is voltage in KV
R is resistance in Ohms/Km
L is length in Km

Annual KilowatthourLoss for 11 KV (HVDS)

KWh loss = $0.008264 \times 10^{-3} (P^2 R L) \times 1920$

= $0.01586688 \times (P^2 R L)$

where P is max. demand in KVA
V is voltage in KV
R is resistance in Ohms/Km
L is length in Km

Taking 400 volts is an ideal case however due to poor voltage regulation average 350 volts are available on the LT side of the Distribution transformers.

Based on the REC formula, calculations have been done for sample feeders in each CPA and it has been observed that the 'Technical Losses' range from 6% to 10 % of the energy sent out in each feeder. Hence an average 'Technical Loss' figure of 8% has been used in the calculations to quantify the energy lost in the 'Baseline case' i.e. LVDS.

In the POA case (11 KV, HVDS), there are practically no 'Technical Losses', and the deemed losses in the Baseline (LVDS) are taken to be energy saved at the grid level. The energy saved at the grid level means equivalent 'Less energy' generated from the fossil fuel based power stations in the Northern Grid leading to corresponding reductions in the carbon dioxide emissions to the atmosphere.

The energy saved at the Grid level is multiplied by the baseline emission factor for the Integrated NEWNE grid to calculate the emissions of carbon dioxide mitigated by the project activity.

Baseline Emission Factor

According to AMS ID, the baseline emission factor is calculated as a Combined Margin (CM), consisting of the combination of Operating Margin (OM) and Build Margin (BM) factors. Since the Northern Region Grid in India is considered to be the geographic and system boundary for the project, the CM emission factor calculated by the Central Electricity Authority (CEA), Ministry of Power, Government of India has taken for the POA.

The Combined Margin (Baseline Emission Factor-CM) for the Northern Region (NR) grid is calculated to be 0.80 tCO_2 / MWh

The copy of CO2 Baseline Database for Indian Power Sector (Version 4.0; September 2008) issued by Central Electricity Authority (CEA) , Ministry of Power , Government of India is available at http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm .

E.6.3. Data and parameters that are to be reported in CDM-SSC-CPA-DD form:

Data / Parameter:	Number of feeders
Data unit:	Nos.
Description:	Feeders from which agricultural pumps are supplied
Source of data used:	Detailed Project Reports (DPRs) for each CPA from PSEB
Value applied:	The exact number is known for each CPA (details available in DPRs)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Low voltage lines are fed from group-feeders.

Any comment:	

Data / Parameter:	Number of transformers dismantled
Data unit:	Nos.
Description:	Existing transformers to be removed during CPA implementation
Source of data used:	Detailed Project Reports (DPRs) for each CPA available with PSEB
Value applied:	The number and the rating are available in the DPR for each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied :	The number of transformers removed would be recorded. The existing installed capacity could be derived. The actual number will be recorded after project implementation.
Any comment:	

Data / Parameter:	Number of new transformers
Data unit:	Nos.
Description:	New or existing small capacity rating transformers to be installed in each CPA
Source of data used:	Detailed Project Reports (DPRs) for each CPA available with PSEB
Value applied:	The number and rating are available in the DPR for each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied :	A pump load matching capacity transformer (6.3 to 25 kVA) is installed to supply electricity to each AP consumer.The installed capacity could be derived. The actual number would be recorded during project implementation.
Any comment:	

Data / Parameter:	Length of distribution network (LVDS) in each CPA
Data unit:	Km
Description:	The total length of the distribution lines from feeders to dedicated transformers serving agricultural consumers
Source of data used:	Detailed Project Reports (DPRs) for each CPA available with PSEB
Value applied:	The length is known for each feeder
Justification of the choice of data or description of measurement methods and procedures actually applied :	The lines length is used to calculated losses using REC's guidelines
Any comment:	The calculations would be used to arrive at the averaged Technical losses as the percentage of the energy sent from Feeder in each CPA

Data / Parameter:	Length of distribution network (**HVDS**) in each CPA
Data unit:	Km
Description:	The total length of the distribution lines from feeders to dedicated transformers serving agricultural consumers

Source of data used:	Detailed Project Reports (DPRs) for each CPA available with PSEB
Value applied:	The length is known for each feeder
Justification of the choice of data or description of measurement methods and procedures actually applied :	The lines length is used to calculate losses using REC's guidelines
Any comment:	The calculations would be used to arrive at the averaged Technical losses as the percentage of the energy sent from Feeder in each CPA

Data / Parameter:	**Energy sent out from each feeder (LVDS)**
Data unit:	kWh
Description:	Input energy sent-out v/z energy recorded at the sub-station in the project within the CPA boundary prior to conversion to HVDS
Source of data used:	PSEB metered data
Value applied:	Value varies for each feeder in the CPA.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The average annual energy sent out will be calculated over the last three years for each CPA for the baseline.
Any comment:	The calculations would be used to arrive at the baseline energy sent out and to calculate the averaged technical losses as the percentage of the energy sent from Feeder in each CPA

Data / Parameter:	**Voltage available at each feeder (LVDS)**
Data unit:	KV
Description:	Voltage recorded at the feeder within the CPA boundary for each year and each feeder, prior to conversion to HVDS
Source of data used:	PSEB metered data
Value applied:	Value varies for each feeder in the CPA.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The average annual energy sent out will be calculated over the last three years for each CPA for the baseline.
Any comment:	The calculations would be used to arrive at the baseline energy sent out , current and to calculate the averaged technical losses as the percentage of the energy sent from Feeder in each CPA

Data / Parameter:	Resistance of conductor in the distribution network (LVDS/HVDS) in each CPA
Data unit:	Ohms/Km

Description:	The average resistance of the conductor per unit length , in the distribution lines from feeders to transformers .
Source of data used:	Detailed Project Reports (DPRs) for each CPA available with PSEB
Value applied:	The amount is known for each feeder
Justification of the choice of data or description of measurement methods and procedures actually applied :	The resistance per unit length is used to calculate 'technical losses' using REC's guidelines
Any comment:	The calculations would be used to arrive at the averaged Technical losses as the percentage of the energy sent from Feeder in each CPA

Data / Parameter:	**Emission Factor for the NEWNE Grid**
Data unit:	tCO2/MWh
Description:	Grid Emission Factor for NEWNE grid
Source of data used:	CEA data
Value applied:	0.80
Justification of the choice of data or description of measurement methods and procedures actually applied :	Central Electricity Authority (India) is a government body and data published is in line with the ACM0002/ Version07 and the tool to calculate grid emission factor (version 1.1). http://www.cea.nic.in/planning/c%20and%20e/user_guide_ver4.pdf
Any comment:	

E.7. Application of the monitoring methodology and description of the monitoring plan:

D.7.1. Data and parameters to be monitored by each SSC-CPA:

(Copy this table for each data and parameter)

Data / Parameter:	Number of feeders
Data unit:	Nos.
Description:	Feeders from which agricultural pumps are supplied
Source of data to be used:	Detailed Project Reports (DPRs) for each CPA from PSEB
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The exact number is known for each CPA (details available in DPRs)
Description of measurement methods and procedures to be applied:	Details available in DPRs for each CPA
QA/QC procedures to	Cross verification with the archived/updated PSEB records

be applied:	
Any comment:	

Data / Parameter:	**Energy sent out from each feeder**
Data unit:	kWh
Description:	Annual input energy sent-out v/z energy recorded at the sub-station in the project within the CPA boundary for each year and each feeder
Source of data to be used:	PSEB metered data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Value varies for each feeder in the CPA.
Description of measurement methods and procedures to be applied:	This is a 'Metered Data'. The Energy Meters used by PSEB are Bureau of Indian Standards certified meters. PSEB follows its standardized policy on 'recording measurements and calibration'. Feeder wise 'Log' is maintained by PSEB.
QA/QC procedures to be applied:	'Spot Checks' would be made to verify the accuracy of the recorded 'Metered Data' and on implementation of the PSEB policy on calibration of the meters.
Any comment:	

Data / Parameter:	**Voltage available at each feeder (HVDS)**
Data unit:	KV
Description:	Voltage recorded at the feeder within the CPA boundary for each year and each feeder, after conversion to HVDS
Source of data used:	PSEB metered data
Value applied:	Value varies for each feeder in the CPA.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The calculations would be used to compare with the baseline averaged technical losses as the percentage of the energy sent from Feeder in each CPA
Any comment:	

Data / Parameter:	**Emission Factor for the NEWNE Grid**
Data unit:	tCO2/MWh
Description:	Grid Emission Factor for NEWNE grid
Source of data used:	CEA data
Value applied:	0.80
Justification of the choice of data or description of measurement methods and procedures actually	Central Electricity Authority (India) is a government body and data published is in line with the ACM0002/ Version07 and the tool to calculate grid emission factor (version 1.1).

applied :	http://www.cea.nic.in/planning/c%20and%20e/user_guide_ver4.pdf
Any comment:	

E.7.2. Description of the monitoring plan for a SSC-CPA:

In line with AMS II A , the project activity proposes to reduce the 'Technical Losses' through conversion of LVDS to HVDS. The 'Technical Losses' have been analytically calculated using the standard formulas derived by REC. The loss calculations have further been cross-checked in each of the circles through actual measurements.

The 'cross-checked Data' would be made available to the DOE so as to assess the correctness & conservativeness of the calculated technical losses in terms of the percentage of energy sent out at each feeder , both for the baseline as well as the project activity case.

At each CPA level, the energy sent out per feeder would be measured 'on actual basis'ex-post, recorded and archived. The 'Technical loss' reduction by conversion of the LVDS to HVDS and the corresponding ER reductions calculated using the REC derived formulas detailed in sections E.6.1 & E.6.2 above.

The monitoring plan is based on the following records:

- The precise identification of the CPA through : REC identification code, name of scheme and substation
- The name of the person responsible for the CPA, i.e., PSEB official at the substation and his reporting relationship with PSEB official managing the POA at the headquarter level.
- Technical characterization of the CPA: number of feeders, number and capacity of pumps connected to each feeder, length of distribution lines before and after the implementation of the CPA
- Metering records of energy sent out on each feeder. The metered electricity will be registered in the operation book and captured electronically on daily basis.
- Calibration records of the 'Meters' installed at the feeders in each CPA.
- Other parameters like daily supply time, power cut, transformers failure and delay for repair will record on a feeder-basis. These data will serve to verify any inconsistency in the claimed energy savings.

Each CPA would report to the PSEB POA coordinating manager at the headquarters level. The calibration of the meters and the archiving of all the records would be done as per the PSEB standard policy.

E.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of the baseline study & monitoring methodology : November 2007

Name of the responsible person : Er. A.K. Verma, Chief Engineer , PSEB

Annex 1

CONTACT INFORMATION ON COORDINATING/MANAGING ENTITY and PARTICIPANTS IN THE PROGRAMME of ACTIVITIES

Organization:	Punjab State Electricity Board (PSEB)
Street/P.O.Box:	The Mall, Patiala
Building:	
City:	Patiala
State/Region:	Punjab
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Country:	India
Telephone:	0175- 2212069
FAX:	
E-Mail:	ce-re@psebindia.org
URL:	www.psebindia.org
Represented by:	
Title:	Chairman,PSEB
Salutation:	Er.
Last Name:	Brar
Middle Name:	
First Name:	H S
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	mdpseb@yahoo.com

Organization:	International Bank for Reconstruction and Development (IBRD) as a Trustee of Danish Carbon Fund
Street/P.O.Box:	1818 H St
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Country:	USA
Telephone:	202-458-1873
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URL:	www.carbonfinance.org
Represented by:	Ms. Joelle Chassard
Title:	Manager
Salutation:	Ms.
Last Name:	Joelle
Middle Name:	
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Organization:	
Street/P.O.Box:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding available for this program.

Annex 3

BASELINE INFORMATION

Baseline energy due to technical losses

The baseline energy is the technical loss of energy within the project boundary calculated as per AMS II.A provisions. The energy supply to agricultural pumps is metered at every 11 kV feeder level across the Punjab State.

Connected load and other relevant details of the feeders are also available with PSEB and have been used for calculations of Baselines

The Detailed Project Reports (DPRs) for the CPAs/schemes contain the feeder-wise theoretical calculations for computing the 'Technical losses' with existing LVDS, as well as with proposed HVDS systems.

The guidelines followed for the calculation of Technical Losses are issued by REC (Government of India).

The baseline energy is therefore calculated as follows:

Equation 1: $E_{B,j} = E_{AP,j} * l_B$

$E_{B,j}$ Annual energy baseline in kWh for year "j". It represents the energy that would be lost in the absence of the proposed CPA.
$E_{AP,j}$ Annual input energy sent-out viz energy recorded at the sub-station in the project within the CPA boundary for year "j".
l_B Technical losses in percentage for each specific CPA in the baseline (LVDS). These are the average technical losses within the CPA boundary over the three last years.

Standard for Technical losses of energy calculation

The procedures for technical losses calculation are provided by REC. Technical losses are determined after HVDS project implementation. As per REC guidelines, the Power loss (kW_{loss}) is given by:

Equation 2: $KW_{loss} = 8.264 * 10^{-6} * P^2_{max} * R * L /(Df)^2$

Pmax Maximum demand in KVA
R Line resistance in Ohms/km. The value of resistance of various sizes of conductor at 60 ^oC is taken as per REC standards.
L Line length in km
Df Diversity factor which is the sum of individual maximum demand divided by the total max and demand of the sub station. The diversity factor is taken as 1.2 based on actual system parameters as per REC guidelines.

The annual energy loss (E_{loss}) is derived from power loss calculated above:

Equation 3: $E_{loss} = kW_{loss} * LLf * 8760 * 10^{-5}$

Where, $LLf = PF * LF^2 + 0.2 * LF$

LLf Loss load factor.
PF Power factor (0.8 as per REC guidelines).
LF Load factor which the ratio between the average load and the maximum load. REC guidelines recommends to LF equal to 0.3 based on actual system parameters.

The energy input is the metered consumption at feeders' level. Therefore, the technical losses coefficient can be calculated by dividing the annual energy loss by the annual energy sent out on each feeder.

Annex 4

MONITORING INFORMATION

Table 1: List of the 46 HVDS Schemes (CPAs) under Phase I

Sr. No.	Name of Division	Name of the Circle	Code No. of scheme
1.	City West Circle, Ludhiana	Ludhiana	Awaiting Sanction from REC
2.	Bathinda Circle	Bathinda	-do-
3.	Mohali Circle	Mohali	-do-
4.	City East Circle, Ludhiana	Ludhiana	-do-
5.	Ropar, Samrala and Kharar Divn	Ropar	Code-161374
6.	Sangrur Divn.	Sangrur	Code-161366
7.	Jallandhar Circle	Jallandhar	Awaiting Sanction from REC
8.	City and Suburban Division, Barnala	Sangrur	Code-161369
9.	Suburban Divn. Sunam	Sangrur	Code-161398
10.	Dhuri Division	Sangrur	Code-161358
11.	Dirba Division	Sangrur	Code-161376
12.	Khanna ,Doraha & Gobindgarh Division under Khanna Circle	Khanna	Code-161397
13.	Samana & Patran Division	Patiala	Code-161367
14.	Nabha and Rajpura Divn	Patiala	Code-161364
15.	City HSP, Sub HSP, Dusuha, Bhogpur, and Mahilpur.	Hoshiarpur	Code-161356
16.	Sub Batala, Pathankot, City Batala, Dhariwal and Gurdaspur	Gurdaspur	Code-161368
17.	City Division, Sunam	Sangrur	Code-161385
18.	East, West and Suburban Patiala	Patiala	Code-161357
19.	West Division, Amritsar	Sub. Amritsar	Awaiting Sanction from REC
20.	Malertkotla Division	Sangrur	Code-161365
21.	Adda Dakha & Ahmedgarh Division	Sub. Ludhiana	Code-161377
22.	Jagraon and Lalto Kalan	Sub. Ludhiana	Code-161375
23.	Mukatsar, Malout, Abohar, Fazilka, Gidderbaha and Badal Divn	Mukatsar	Code-161372
24.	Nawanshehar, Banga & Garshankar Divn.	Nawanshehar	Code-161386
25.	Suburban and East Divn.,Amritsar	Sub. Amritsar	Code-161392
26.	Jalalabad	Ferozpur	Code-161391
27.	Goraya	Nawanshehar	Code-161389

28.	Rayya Divn	Taran Taran	Code-161384
29.	Ajnala & Jandiala	Sub. Amritsar	Code-161390
30.	Suburban Nakodar	Kapurthala	Code-161363
31.	Ferozepur City and Sub Divn.,	Ferozpur	Code-161371
32.	Raikot Divn	Sub. Ludhiana	Code-161370
33.	Sub Divn Kapurthala	Kapurthala	Code-161378
34.	City Divn Nakodar	Kapurthala	Code-161394
35.	Sirhind and Amloh Divn	Khanna	Code-151362
36.	City Kapurthala	Kapurthala	Code-161383
37.	City Tarn Taran & Bhikhiwind	Taran Tarn	Code-161361
38.	Kartarpur Divn	Kapurthala	Code-161393
39.	Sub Divn Moga	Faridkot	Code-161381
40.	Baghapurana Divn	Faridkot	Code-161387
41.	City Divn Moga	Faridkot	Code-161388
42.	Patti Divn	Taran Tarn	Code-161382
43.	Kotkapura Divn	Faridkot	Code-161395
44.	Zira Divn	Ferozepur	Code-161380
45.	Quadian Divn	Gurdaspur	Code-161379
46.	Faridkot Divn	Faridkot	Code-161396