CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

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Energy Efficiency measures at Desalination Plant in Chennai.
Version: 01
Date: 02/01/2008

A.2. Description of the small-scale project activity:

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Chennai Water Desalination Limited (CWDL) is a company created to develop a Desalination Plant that will provide drinking water to the population of Chennai city. The potential production is 100,000 m3/day. The Desalination Plant, whose expect commissioning date is December 2008, will augment the water supply capacity to Chennai City for about 2.5 million people on the basis of 40 litres per day. This is a great boon for the water starved city.

The project activity, an energy efficiency measure is an application of the technology of the variable frequency drive in the Reverse Osmosis process. To improve the operational efficiency of the plant and to develop into a more environmentally friendly operation, five (High Voltage) Variable Frequency Drives (HV-VFD) have been set up for High Pressure Pumps.

The purpose of the project activity is to improve the energy efficiency levels in the High Pressure Pumps. These pumps provide high pressure water needed in osmosis membranes and the power consumption in this step amounts more than 65% of the whole energy consumed in the plant. The installation of HV-VFD allows adaptation to sea water conditions in the pressure requested to High Pressure Pumps, and therefore, in energy consumption.

This energy conservation would reduce the demand for an equivalent generation of electrical energy on the grid mix and result in indirect CO2 emission reductions, at the grid power plants. The total expected annual electricity demand reduction is 19,552 MWh per year.

The main benefits of the project activity may therefore be summarized as:

- **Environmental:**

"This should include a discussion of impact of the project activity on resource sustainability and resource degradation, if any, due to proposed activity; bio-diversity friendliness; impact on human health; reduction of levels of pollution in general"[1]

- Reduction in electrical energy losses
- Energy conservation
- Indirect Reduction of GHG / CO2 emissions at the coal fired power plant
- Conservation of coal, a non-renewable natural resource
- Abatement of impact on the marine ecosystem produced by delivered brine in the sea. Variable Frequency Drives always guarantee the same salt dilution in the rejected water flow. The brine rejected will be of the order of 137 MLD (5700 m^3/hour) with a salinity

[1] Given that is prerogative of the host Party to confirm whether a CDM assists it in achieving sustainable development, this is taken from INDIA DNA, http://cdmindia.nic.in/host_approval_criteria.htm

of 70 PSU (Practical Salinity Units) released into the sea, using HDPE (High-Density Polyethylene) submarine pipelines of 1 x 1400mm diameter and diffuser ports outfall system, which has been designed to have maximum mixing in order to attain ambient salinity within a short distance.

- Reduction in the noise level by adapting the energy needed in High Pressure Pumps. It will contribute to keep final noise levels within limits prescribed by Ministry Of Environment & Forests (see Enclosure II "Study on Terrestrial Environmental Management Report".

- **Social**

"The CDM project activity should lead to alleviation of poverty by generating additional employment, removal of social disparities and contribution to provision of basic amenities to people leading to improvement in quality of life of people."[2]

- The desalination plant, where is located the project activity, has generated employment opportunities for the local people, both during construction (400 employments approx.) and operation phases (75 employments approx.). Further it will provide direct and indirect employment for about 200 persons on account of contractual job as well as auxiliary services like maintenance of pipes, equipments etc. There will be no adverse impact on surrounding population on factors like culture, religion, etc.
- Also the interaction with international experts enhanced the skill sets of manpower. Indirect employment will be generated for the equipment supplier, contractors & technical consultants.

- **Economic**

"The CDM project activity should bring in additional investment consistent with the needs of the people."[3]

- This project will demonstrate the use of new financial mechanism (CDM) in raising finance for energy efficiency measures.
- Contribution towards meeting electricity demand, allowing grid to divert electricity for other activities.
- The project has created a business opportunity for local stakeholders such as suppliers, manufacturers, contractors, bankers, etc.
- The desalination plant leads to an investment of about USD 130 million to a developing region.
- Improvement of access roads with connected civil works, will give indirect benefit to many local people. Overall, the construction phase will bestow a positive impact on the area. During the operational phase, the project will provide permanent employment for about 30 people.

[2, 3] http://cdmindia.nic.in/host_approval_criteria.htm

A.3. Project participants:

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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)
India	Chennai Water Desalination Ltd. (private entity)	No
Spain	Zero Emissions Technologies, S.A (private entity)	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

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A.4.1.1. Host Party(ies):

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India

A.4.1.2. Region/State/Province etc.:

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Tamil Nadu State

A.4.1.3. City/Town/Community etc:

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Kattupalli Village, Minjur Block, Chennai City.

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

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The Desalination plant is proposed to be set up about 4 km north of Ennore Port, which is 22 km north of Chennai. The project site lies in Kattupalli village, Minjur, between Buckingham canal and the Bay of Bengal. The desalination plant will be located approximately at latitude 13º19’01’’N and longitude 80º20’25’’E.


Afghanistan
Kabul
Islamabad
Srinagar
Jammu
Amritsar
Pakistan
Chandigarh
Simla
Indus R.
Yamuna R.
Ganges R.
Borders of Kashmir are in dispute; India, Pakistan and China have differing claims.
China
Tongtran R. (Yangtze)
Mekong R.
Indus R.
Xiangquan R.
400 km
300 mi
30°
Yarlung R.
(Brahmaputra) R.
Nepal
Kathmandu
Bhutan
Ledo
Itanagar
New Delhi
Jaipur
Agra
Lucknow
Kanpur
Allahabad
Varanasi
Ganges R.
Siliguri
Shillong
Kohima
Imphal
Bangladesh
Agartala
Aizawl
Dhaka
Gandhinagar
Kandla
Ahmadabad
Bhopal
Jabalpur
Calcutta
Jamshedpur
Narmada R.
Mahanadi R.
Myanmar (Burma)
Mouths of the Ganges
Veraval
India
Raipur
Cuttack
Bhubaneshwar
20°
Silvassa
Godavari R.
Puri
Mumbai
Pune
N
Irrawaddy R.
Arabian Sea
Hyderabad
Krishna R.
Panaji
Marmagao
Guntakal
Bangalore
Chennai
Mangalore
Cauvery R.
Pondicherry
Cuddalore
Laccadive Islands
Calicut (Khozikode)
Kavaratti
Palk Strait
70°
Tamil Nadu
Andhra Pradesh
Tiruvallur
Chennai
Kancheepuram
Karnataka
Vellore
Krishnagiri
Tiruvannamalai
Villupuram
Dharmapuri
Pondicherry
Salem
Nilgiris
Erode
Namakkal
Cuddalore
Perambalur
Tiruchirappalli
Karaikal
Coimbatore
Karur
Nagapattinam
Thanjavur
Thiruvarur
Dindigul
Pudukkottai
Kerala
Theni
Madurai
Sivaganga
Virudhunagar
Ramanathapuram
Thoothukudi
Tirunelveli
Bay of Bengal
Kanniyakumari
Indian Ocean
Ponneri
Minjur
Kattivakkam
Tiruvottiyur
Madras
Tiruverkadu
Alandur
Pallavaram
Madhavaram
Perungudi
Vengavasal

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

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Following indicative simplified baseline and monitoring methodologies for selected small scale CDM project categories is applied to the project activity:
Type: II – Energy efficiency improvement projects
Title: AMS II D –Energy efficiency and fuel switching measures for industrial facilities version-11
The main parameters of the VFD and High Pressure Pumps are listed in the following tables:

High Pressure Pumps	
Liquid	Filtered sea water
Pumping Temperature	25-31 ºC
Specific gravity at P.T.	1.03 kg/m^3
Capacity	892 m^3/h
Efficiency	85%
Nominal Speed (Pump Speed)	Variable rpm
NPSHr	18-21 m
Motor Power	2200 kW
Motor Voltage	3,3 or 4 kV
Motor Phases	3 ph
Motor Frequency	50 Hz

MV Variable Frequency Driver	
Maximum continuous power	2250 kW
Maximum continuous current	472 A
Efficiency (at nominal load)	98 %
Power factor (at nominal load)	0.96
Type of driver	Cabinet built
Frequency range	0-66 Hz

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

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Fixed crediting period of ten years has been chosen for the project since the beginning of the plant's commissioning. The estimation of total emission reductions as well as annual estimates for the chosen crediting period of ten years has been depicted as follows:

Year	**Estimation of annual emission reductions in tonnes of CO2 e**
1st Year	19,419
2nd Year	18,445
3rd Year	17,610

4th Year	16,916
5th Year	16,360
6th Year	15,945
7th Year	15,668
8th Year	15,532
9th Year	15,535
10th Year	15,678
Total estimated reductions (tonnes of CO2 e)	167,107
Total number of crediting years	10 years
Annual average of the estimated reductions over the crediting period (tCO_2 e)	16,711

A.4.4. Public funding of the small-scale project activity:

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No public funding is available for the project activity from countries included in Annex 1.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

According to appendix C of simplified modalities and procedures for small-scale CDM project activities, 'debundling' is defined as the fragmentation of a large project activity into smaller parts. A small-scale project activity that is part of a large project activity is not eligible to use the simplified modalities and procedures for small-scale CDM project activities. According to paragraph 2 of Appendix C[3] "A proposed small-scale project activity shall be deemed to be a de-bundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants;
- In the same project category and technology/measure;
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point

According to above-mentioned points of de-bundling, proposed project activity is not a part of any of the above, therefore, considered as small scale CDM project activity.

[3] http://cdm.unfccc.int/Projects/pac/howto/SmallScalePA/sscdebund.pdf

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

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Title: AMS. II.D (Version 11 Sectoral Scope: 04 EB 35)
TYPE II - Energy Efficiency Improvement Projects
II.D. Energy efficiency and fuel switching measures for industrial facilities

Reference:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

As per paragraph 7 of AMS II.D "Each energy form in the emission baseline is multiplied by an emission coefficient (in kg CO2equ/kWh). For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category AMS I.D and herewith the "Tool to calculate the emission factor for an electricity system". For fossil fuels, the IPCC default values for emission coefficients may be used"

B.2 Justification of the choice of the project category:

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As per Appendix B of the simplified modalities and procedures for small scale CDM project activities, the small scale methodology AMS II.D *i.e.* "Type II – Energy efficiency improvement projects of Category II.D – Energy efficiency and fuel switching measures for industrial facilities" (Version 11, Scope 4, EB 35) has been selected for the project activity as it meets the following requirements:

Methodology Requirement	Applicability of Project Activity
This category comprises any energy efficiency and fuel switching measure implemented at a single industrial or mining and mineral production facility.	The project activity includes measures to improve the energy efficiency of Reverse Osmosis for desalination process that reduces electrical energy consumption on the demand side.
This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B	The project activity improves the efficiency of desalination process and the energy efficiency measures involve installation of Variable Frequency Drives (HV-VFD) for High Pressure Pumps. Project does not involve any activity leading to fuel switch.
The measures may replace, modify or retrofit existing facilities or be installed in a new facility	The Variable Frequency Drives are installed in a new facility, during construction of the plant
The aggregate energy savings of a single project may not exceed the equivalent of 60 GWhe per year. A total saving of 60 GWhe per year is equivalent to a maximal saving of 180 GWhth per year in fuel input.	The annual energy reduction from the project activity is about 19.5 GWhe per year which is below the limit of 60 GWhe per year as specified in the methodology.

B.3. Description of the project boundary:

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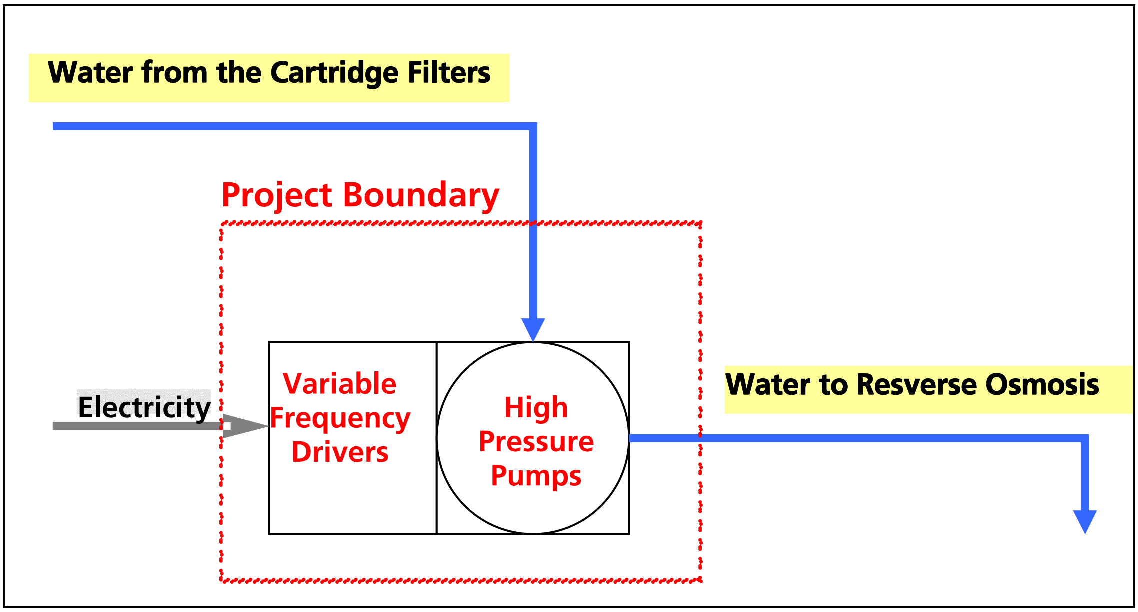
As per the approved methodology II.D "Energy efficiency improvements projects", the project boundary is "the physical, geographical site of the industrial or mining and mineral production facility, processes or equipment that are affected by the project activity".
In our case, the project activity boundary is: Variable Frequency Drives (5 units), high pressure pumps (5 units), and the connexion to the grid.



B.4. Description of baseline and its development:

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The project category applicable to the proposed CDM project is II D. The project activity, based on the installation of Variable Frequency Drives (HV-VFD) for high pressure pumps in a Desalination Plant, will save 19,55 million KWh per annum on an average.

Therefore, a conventional energy equivalent of 195,5 million KWh for a period of 10 years would be conserved by the project activity. Without the project activity, the same energy load would have been taken up by power plants in the grid and emission of CO2 would have occurred due to coal combustion (proportional share of thermal power in generation mix).

The baseline methodology has followed the one specified under Project category II.D, paragraph 5 "in the case of a new facility the energy baseline consists of the facility that would otherwise be built".

The annual energy baseline values (annual energy consumption in absence of project activity) for the crediting years are calculated by estimating the "power that would be consumed" and "operating hours" of the High Pressure Pumps that "would have been installed" without HV-VFD.

The "power that would be consumed" by the High Pressure Pumps in absence of the project activity is obtained from calculations on energy consumption by CWDL´s design engineers (Enclosure I). These calculations are based on the fact that without HV-VFD, High Pressure

Pumps would be operating continuously at the maximum pressure needed to reach contract's commitments.

Emission Factor

The Central Electricity Authority (CEA) of India is a certified government body and a useful resource for grid operation and management data such as performance reviews of power plants, inter-state purchases of power and emission factors of regional grids in India. The CEA has estimated the Emission Factor for the different grids in India, the details of which are available on the following website:

http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm

CEA has compiled the CO2 Database for the Fiscal Years (FY) 2000-01 to 2006-07 based upon generation, fuel consumption and fuel gross calorific value (GCV) data furnished by each power station. In cases where the station could not provide reliable data for all the relevant parameters, assumptions were made as described below:

Assumptions at Station Level	
Net generation:	For hydro stations, only gross generation was available, but not net generation data. Instead, the CEA standard value for auxiliary power consumption in hydro units (0.5%) was applied to derive the net generation from the gross generation data reported by the stations. Likewise, CEA standard values for auxiliary power consumption had to be applied for some of the gas and diesel-fired thermal stations.
Gross Calorific Value (GCV)	Default values were used for some thermal stations where station-specific GCVs were not available.
Assumptions at Unit Level (for those into the BM)	
Gross generation	For some stations, gross generation data were not available at unit level. Instead, the plant load factor of the respective station was used to derive the gross generation of the units. For units commissioned after the start of the relevant fiscal year, the gross generation was further adjusted pro rata the number of days since commissioning.
Net generation	Net generation data is generally not measured at unit level. Two distinct approaches were applied to estimate net generation. (i) In cases where all units of a station fall into the build margin or where all units of a station have the same installed capacity, the auxiliary consumption (in % of gross generation) of the units was assumed to be equal to that of the respective station. (ii) In all other cases, standard values for auxiliary consumption adopted by CEA were applied.
Fuel consumption and GCV	Fuel consumption and GCV are generally not measured at unit level. Instead, the specific CO2 emissions of the relevant units were directly calculated based on heat rates

In order to ensure conservativeness of calculations, the following approaches and assumptions had been taken by CEA:

- The quality of station-level data was ensured through extensive plausibility testing and interaction with the station operators.
- In cases of data gaps at station level, standard data from CEA was used. For example, standard auxiliary power consumption was assumed for a number of gas-fired stations. Comparison with monitored values shows that these standard values are rather conservative, i.e. they lead to a somewhat lower heat rate and hence lower emissions than observed in many stations.
- Where required, the emission factors of thermal units were also derived from standard CEA values (design heat rate plus 5%). Again, these values are conservative (i.e. relatively low) compared to the heat rates observed in practice. See Section 4.3 for details on the build margin calculation.
- The fuel emission factors and oxidation factors used are generally consistent with IPCC defaults. For coal, the emission factor provided in India's Initial National Communication was used (95.8 t CO_2/TJ on NCV basis), being somewhat lower than the IPCC default for sub-bituminous coal (96.1 t CO_2/TJ)

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

As per the decision 17/cp.7 paragraph 43, *"a CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity"*

Barriers and Additionality
Referring to attachment A to appendix B document of "indicative simplified baseline and monitoring methodologies for selected small scale CDM project activity categories", project participants are required to provide a qualitative explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers. At least one of the listed elements should be identified in concrete terms to show that the activity is either beyond the regulatory and policy requirement or improves compliance to the requirement by removing barrier(s); the guidance provided herein has been used to establish project additionality. The barriers that were considered are listed below:

A. Investment barrier
B. Technological barrier
C. Barrier due to prevailing practice
D. Regulatory/Legal requirements
E. Other barriers

A. Investment Barrier

Project participants have bought this enormous Variable Frequency Drives, what represents an important expenditure, for the CDM project activity with simple paybacks 4 years estimated based on the projected energy savings due to installation of Variable Frequency Drives.

Project participants invested such huge amount only to save marginal amounts of power with a concern for global warming and GHG emissions reduction which is not commonly seen in any process industry sector in India. The CDM benefit is one of the drivers, but the satisfaction of contributing towards global partner of climate change has deeply motivated project participants management for going ahead with the energy efficiency project.

Further the maintenance or reparation of HV VFD and its associated reduction in the electrical energy is governed by external factors like ambient temperatures and water salinity which vary seasonally, and are beyond project participant's control. Therefore there is an element of risk associated to the reduction in the electrical energy consumption due to project activity over the crediting period.

B. Technological Barrier

The project implementation could result in major faults and maintenance problems during the development and operation stages. The inclusion of these huge devices based on the highest technology of their kind, obviously increases the possibilities of failure in the process, with the additional problem that they are coordinated with High Pressure Pumps. This can have a cascading or domino effect of failure in critical production areas directly or indirectly connected .So production could be hampering and could result in lost man-day and lost in water quality. Therefore, a key barrier to implement such an activity is preparedness of operational staff on process.

C. Barrier due to prevailing practice

The thermal desalination process for water distillation was the technology employed in the first major desalination plants in the 1950s which were predominantly in the Middle East region.

Membrane technologies were developed in the 1960s and 1970s and by the late 1980s, reverse osmosis desalination technology made up 40% of desalination plants worldwide. This has now increased to levels approaching 60% in 2006.

Desalination in India is in a primitive state. The private sector use disinfection/demineralise mainly and only in last years the Reverse Osmosis desalination has became a feasible alternative.

Tamil Nadu has a long coastline and the groundwater in the towns and villages along the coastal belt is saline due to natural and man-made causes such as overdrawing. There are also no other alternate surface water sources to meet drinking water needs. This has necessitated special programmes such as setting up desalination plants. By 2005, 11 plants covering 360 habitations were completed and commissioned in Ramanathapuram district in Tamil Nadu. The major plant among them is at Narippaiyur with a capacity of 3000 m^3 per day covering 296 rural habitations. Reverse osmosis is adopted as the desalination technology here.

As it can be seen, there are no comparable plants installed in India with the project developed by CWDL, it can be counted as "first of its kind" in India. Therefore, the energy efficiency measures can be considered as "unique" not only in Tamil Nadu State, but in India. The installation of Variable Frequency Drives is a pioneer activity in Reverse Osmosis Desalination Plants all over the world, and obviously in grater extent in developing countries.

D. Regulatory/Legal requirements

There was no legal binding on CWDL to take up the project activity.

Indian government enacted the Energy Conservation Act in the year 2001, with the main objective of institutionalizing and strengthening "delivery mechanism for energy efficiency services in the country and foster the much-needed coordination between the various energy providers and distributors".

Therefore, the act is more to encourage rather than regulate the adoption of energy efficiency programmes. There is no mandatory law in the country which ensures compulsory adoption of energy efficiency measures. Therefore, all conservation measures adopted by CWDL is over and above any requirement under national law or regulation.

E. Other Barriers

About 80% of the electricity generated in India is produced by power plants run either by state government or central government agencies and supplied at subsidised rates. Thus a high user discount rate and a low electricity tariff does not encourage energy savings from the user's perspective.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The baseline calculations are carried out as under:

Emission Factor Calculations

The approved small scale methodology II.D, in paragraph 7, leads to methodology I D:

"*Each energy form in the emission baseline is multiplied by an emission coefficient (in kg CO2e/kWh). For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category I.D.*"

The approved small scale methodology I.D mandates using methodology specified in "Methodological tool to calculate the emission factor for an electricity system", version 01, EB 35, for calculation of emission factor due to displacement of grid electricity. The CEA database has been calculated on the basis of this methodological tool.

The baseline is calculated using the combined margin approach. The baseline emission factor is calculated in the following steps:

Step1. Identify the relevant electricity power system

The Indian power system is divided into five independent regional grids, namely Northern, Eastern, Western, Southern and North-Eastern. Each grid covers several states, as shown in table below:

Northern	Western	Southern	Eastern	North-Eastern
Chandigarh	Chhattisgarh	Andhra Pradesh	Bihar	Arunachal Pradesh
Delhi	Gujarat	Karnataka	Jharkhand	Assam
Haryana	Daman & Diu	Kerala	Orissa	Manipur
Himachal Pradesh	Dadar & Nagar Haveli	**Tamil Nadu**	West Bengal	Meghalaya
Jammu & Kashmir	Madhya Pradesh	Pondicherry	Sikkim	Mizoram
Punjab	Maharashtra	Lakshadweep	Andaman-Nicobar	Nagaland
Rajasthan	Goa			Tripura
Uttar Pradesh				
Uttaranchal				

The project activity is located in Chennai, Tamil Nadu state, so the suitable grid for calculating the Emission Factor is **Southern Grid.**

Step 2 Select an operating margin (OM) method

The calculation of the operating margin emission factor ($EF_{OM,y}$) is based on one of the following methods:

a) Simple OM
b) Simple adjusted OM
c) Dispatch data analysis OM
d) Average OM

Method (c) Dispatch data analysis OM

If the dispatch data is available, method (c) should be the first choice. This method requires the dispatch order of each power plant and the dispatched electricity generation of all the power plants in the power grid during every operation hour period. Since the dispatch data are not available in India, this method is not applicable for the proposed project activity.

Method (b) Simple adjusted OM

The application of simple adjusted OM method requires the annual load duration curve of the power grid and the load data of every hour data during the whole year on the basis of the time order. Then again, the dispatch data and detailed load curve data were not available in India. Therefore, method (b) is not applicable for the proposed project as well.

Method (d) Average OM

Method (d) will only be used when (1) low-cost/must run resources constitute more than 50% of total grid generation and detailed data to apply method (b) is not available, and (2) where detailed data to apply option (c) above is unavailable. From 2001 to 2006, the low-cost/ must run resources constitute less than 50% of total amount grid generation output for the Southern Grid (this method must be used for projects located in North-East grid). Hence method (d) is not applicable for the project activity (See Table below).

Method (a): Simple OM

The simple OM method can only be used where low-cost/must run resources constitute less than 50% of total grid generation in: (1) average of the five most recent years, or (2) based on long-term normal for hydroelectricity production. Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

Share of Must-Run (Hydro/Nuclear) (% of Net Generation)

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
North	25.9%	25.7%	26.1%	28.1%	26.8%	28.1%	27.1%
East	10.8%	13.4%	7.5%	10.3%	10.5%	7.2%	9.0%
South	28.1%	25.5%	18.3%	16.2%	21.6%	27.0%	28.3%
West	8.2%	8.5%	8.2%	9.1%	8.8%	12.0%	13.9%
North-East	42.2%	41.7%	45.8%	41.9%	55.5%	52.7%	44.1%
India	19.2%	18.9%	16.3%	17.1%	18.0%	20.1%	20.9%

The above data clearly shows that the percentage of total grid generation by low cost/must run plants (on the basis of average of five most recent years) for the southern regional grid is less than 50 % of the total generation.

In conclusion, method (a) is the only reasonable and feasible method among the four methods for calculating the Operating Margin emission factor ($EF_{OM,y}$) of the Southern Grid in India.

Likewise, for the simple operating margin, the emission factor can be calculated using either the two following data vintages:

- Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period, or
- Ex post option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods

For our project activity, ex-ante option has been chosen, using the full generation-weighted average for the most recent 3 years for which data are available at the time of PDD submission.

Also, following the Tool, the electricity imports have been included in calculations, treated as one power plant.

Step 3: Calculate the operating margin emission factor according to the selected method

As the Tool mandates, the simple operating margin emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. It may be calculated:

- Based on data on fuel consumption and net electricity generation of each power plant/unit (Option A)
- Based on data on net electricity generation, the average efficiency of each power unit and the fuel type(s) used in each power unit (Option B), or
- Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (Option C)

Option A should be preferred and must be used if fuel consumption data is available for each power plant/unit. In other cases, option B or option C can be used. For the purpose of calculating the simple OM, Option C should only be used if the necessary data for option A and option B is not available and can only be used if only nuclear and renewable power generation are considered as low-cost/must-run power sources and if the quantity of electricity supplied to the grid by these sources is known.

Therefore, the CEA opts for option B, the one that better fits with available data in India. For this option, the simple OM emission factor is calculated based on the electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OMsimpley} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum EG_{m,y}} \qquad (1)$$

Where:

$EF_{grid,OMsimple,y}$	= Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	= CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	= All power units serving the grid in year y except low-cost / must-run power units
y	= three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option).

The emission factor of each power unit m should be determined as follows:

Option B1. If for a power unit m data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_{i} FC_{i,m,y} \cdot EF_{CO2,i,y} \cdot NCV_{i,y}}{EG_{m,y}} \qquad (2)$$

Where:

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)

$FC_{i,m,y}$	= Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit)
$NCV_{i,y}$	= Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO2,I,y}$	= CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
m	= All power units serving the grid in year y except low-cost / must-run power units
i	= All fossil fuel types combusted in power unit m in year y
y	= three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)

Option B2. If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,y} \cdot 3.6}{\eta_{m,y}} \qquad (3)$$

Where:

$EF_{EL,m,y}$	= CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{CO2,m,i,y}$	= Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)
$\eta_{m,y}$	= Average net energy conversion efficiency of power unit m in year y (%)
y	= three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)

Option B3. If for a power unit m only data on electricity generation is available, an emission factor of 0 tCO_2/MWh can be assumed as a simple and conservative approach.

Where Option C is used, the simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants / units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{Grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \cdot EF_{CO2,i,y} \cdot NCV_{i,y}}{EG_y} \qquad (4)$$

Where:

$EF_{grid,OMsimple,y}$	= Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,y}$	= Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)

$NCV_{i,y}$	= Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO2,i,y}$	= CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
EG_y	= Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year y (MWh)
i	= All fossil fuel types combusted in power sources in the project electricity system in year y
y	=Three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)

The operating margin emission factor has been calculated following Option B1, with an adaptation to available data: instead of NCV, the CEA used the GCV (Gross calorific value of the fuel), the CO2 emission factor of the fuel, based on GCV, and the Oxidation Factor of the fuel. So, CO2 emissions of thermal stations were calculated using the formula below:

$$AbsCO_2(station)_y = \sum_{i=1}^{2} FuelCon_{i,y} \times GCV_{i,y} \times EF_i \times Oxid_i \qquad (5)$$

Where:

$AbsCO_{2,y}$	= Absolute CO_2 emission of the station in given fiscal year 'y'
$FuelCon_{i,y}$	= Amount of fuel of type I consumed in the fiscal year 'y'
$GCV_{i,y}$	= Gross calorific value of the fuel i in the fiscal year 'y'
EF_i	= CO_2 emission factor of the fuel i based on GCV
$Oxid_i$	= Oxidation factor of the fuel i

Thus, using (**1**), the $EF_{OM,y}$ is estimated to be:

- For the year 2004-2005 the $EF_{OM,y}$ is 1.0009 tCO2/MWh
- For the year 2005-2006 the $EF_{OM,y}$ is 1.0079 tCO2/MWh
- For the year 2006-2007 the $EF_{OM,y}$ is 1.0030 tCO2/MWh

The final $EF_{OM,y}$ based on three years average is estimated to be **1.0039 tCO2/MWh**.

Step 4: Identify the cohort of power units to be included in the built margin

The build margin has to be calculated by constituting a sample group m from either the 5 most recently built power plants or the power plant capacity additions in the electricity system that comprise 20% of the system generation (that have been built most recently). The sample group that comprises larger annual generation from either of these has to be chosen. It is observed that the generation from the sample group that comprises 20% of the system generation has larger generation than the 5 most recently built plants. So the Build Margin is calculated from the sample group comprising the most recently additions to the grid that comprise 20% of the system generation.

As the Tool mandates, in terms of vintage of data, project participants can choose between one of the following two options:

- Option 1. For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

- Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which

For this project, Option 1 is selected to calculate Emission Factor of Build Margin.

Step 5. Calculate the build margin emission factor

Unit-level CO_2 emissions were only calculated for units falling in the build margin, using the next formula:

$$AbsCO_2(unit)_y = SpecCO_2(unit)_y \times NetGen(unit)_y \tag{6}$$

Where:

$AbsCO_2$ = Absolute CO2 emissions of thermal units
$SpecCO_2$ = Specific emissions
NetGen = Net generation

A unit was assumed to have the same specific emissions as the corresponding station in the following three cases:

- If all units of a station fall into the build margin;
- If all units of a station have the same installed capacity;
- If the default specific emissions for the respective station type is higher than the corresponding station's specific emissions, and the concerned unit is capacity-wise among the largest of the station.

For over 90% of all thermal units in the build margin 2005-06, one of these cases applied. In the remaining cases, the specific emissions of the units were derived from conservative standard heat rate values, defined as the design heat rate plus 5%

The $EF_{BM,y}$ is estimated as **0.7055 tCO2/MWh** (with sample group m constituting most recent capacity additions to the grid comprising 20% of the system generation).

Step 6. Calculate the combined margin emissions factor

The baseline emission factor i.e. the Combined Margin emission factor will be calculated as the weighted average of Operating Margin and Build Margin. I.D mandates the uses of emission reduction calculation procedures given in "Tool to calculate the emission factor for an electricity system".

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \qquad (7)$$

Hence the following default values should be used for w_{OM} and w_{BM}:

- Wind and solar power generation project activities: w_{OM}=0.75 and w_{OM}=0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.
- All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

Baseline Emission Factor: 0.5* EF_{OM} + 0.5 * EF_{BM} = **0.8547 tCO2/MWh**

Total amount of emissions per year in the baseline is calculated as the result of multiplying this Emission Factor for the total amount of MWh per year consumed in High Pressure Pumps that “would have been installed” without implementation of Variable Frequency Drives.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$EF_{OM,y}$
Data unit:	$kgCO_2e/kWh$
Description:	Southern Grid-Simple Operating Margin
Source of data used:	CEA Emission Factor
Value applied:	1.0039
Justification of the choice of data or description of measurement methods and procedures actually applied :	Southern Grid-Simple Operating Margin obtained from published data Central Electricity Authority (CEA), Government of India (www.cea.nic.in) CO_2 Baseline Database for the Indian Power Sector Version 3.0.
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$EF_{BM,y}$
Data unit:	$kgCO_2e/kWh$
Description:	Southern Grid-Build Margin
Source of data used:	CEA Emission Factor
Value applied:	0.7055
Justification of the choice of data or description of measurement methods and procedures actually applied :	Southern Grid-Build Margin obtained from published data Central Electricity Authority (CEA), Government of India (www.cea.nic.in) CO_2 Baseline Database for the Indian Power Sector Version 3.0.
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$EF_{CM,y}$
Data unit:	$kgCO_2e/kWh$
Description:	Southern Grid-Combined Margin
Source of data used:	CEA Emission Factor
Value applied:	0.8547
Justification of the choice of data or description of measurement methods and procedures actually applied :	Southern Grid-Combined Margin obtained from published data Central Electricity Authority (CEA), Government of India (www.cea.nic.in) CO_2 Baseline Database for the Indian Power Sector Version 3.0.
Any comment:	Data will be kept for crediting period + 2 years.

Data / Parameter:	$\mathbf{EC}_{HP,\ baseline}$
Data unit:	kWh
Description:	Energy consumption of High Pressure Pumps that would have been installed in absence of Variable Frequency Drives
Source of data used:	CWDL's design engineers
Value applied:	See Enclosure I
Justification of the choice of data or description of measurement methods and procedures actually applied :	See Enclosure I
Any comment:	The value will be constant for entire crediting period.

B.6.3 Ex-ante calculation of emission reductions:

>>
The project activity reduces carbon dioxide through an energy efficiency process. The emission reduction ERy due to project activity during a given year y is calculated as per the formula given below:

$$ERy = BEy - PEy - Ly$$

Where:
BE y =Baseline emissions (Please refer section B)
PE y = Project emissions; PE y = 0 for project activity
Ly = Emissions due to leakage; Ly = 0 for project activity, over crediting period

For the leakage, the methodology mandates that "*if the energy efficiency technology is transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered*".
In our project activity, the technology installed is 5 new HV VFDs set up in a new facility, so we can consider no leakage for our energy efficiency.
See Enclosure I for detailed information.

B.6.4 Summary of the ex-ante estimation of emission reductions:

>>

Year	Estimation of Project Activity Emissions (tCO_2)	Estimation of Baseline Emissions (tCO_2)	Estimation of Leakage (tCO_2)	Estimation of overall Emission Reduction (tCO_2)
1	60,077	79,495	0	19,419
2	61,051	79,495	0	18,445
3	61,885	79,495	0	17,610
4	62,580	79,495	0	16,916
5	63,135	79,495	0	16,360
6	63,551	79,495	0	15,945
7	63,827	79,495	0	15,668
8	63,964	79,495	0	15,532
9	63,960	79,495	0	15,535
10	63,818	79,495	0	15,678
Total (tonnes CO_2)	627,847	794,955	0	167,107

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

The following two sections (B.7.1 & B.7.2) provides a description of the application of the monitoring methodology and description of the monitoring plan, including identification of the data to be monitored and the procedures that will be applied during monitoring.

B.7.1 Data and parameters monitored:

Data / Parameter:	**EC_{HP}**
Data unit:	kWh
Description:	Energy consumption of High Pressure Pumps with Variable Frequency Drives installed.
Source of data to be used:	In plant record, based on the energy meter from High Pressure Pump.
Value of data	To be measure from normal operation of High Pressure Pumps
Description of measurement methods and procedures to be applied:	Data collected from the operation records (SCADA), and the annual amount of MWh consumed by the pumps will be use for calculate emission reductions.
QA/QC procedures to be applied:	Monitoring systems will follow procedures under the ISO 9001
Any comment:	Data will be kept for crediting period + 2 years.

B.7.2 Description of the monitoring plan:

>>

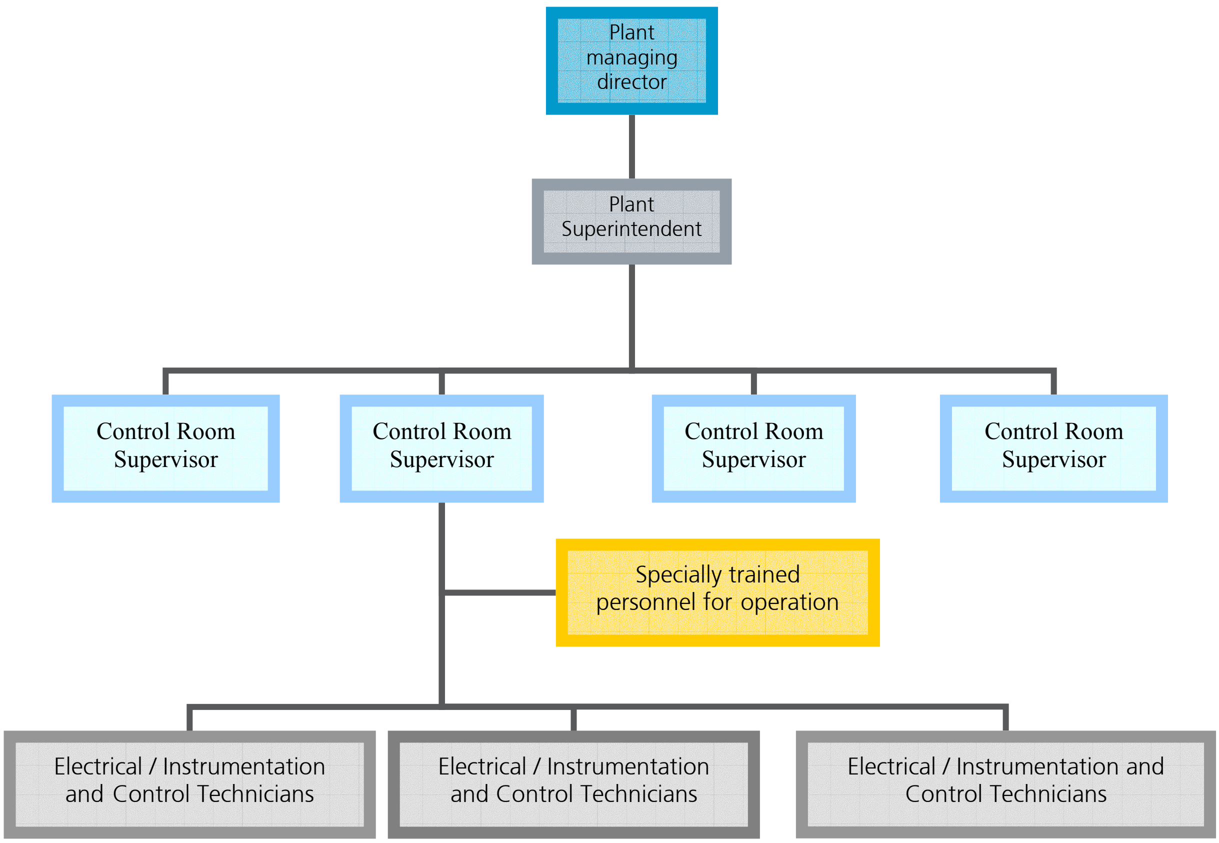
AMS-II-D mandates, in case of a new facility, that monitoring shall consist of:

A. Metering the energy use of the equipment installed;
B. Calculating the energy savings due to the equipment installed

The aim of our monitoring plan is to make sure that metering the energy use during the project activities' vintage is completed, consistent, clear and precise. Emission reduction calculations will be done annual by Zero Emission's engineers based on the data collected.
Likewise, a Quality Control Plan has been developed by CWDL, and can be verified by the Designated Operational Entity. This Quality Control Plan is based on UNE-EN-ISO 9001.

1. Monitoring Subject
Due to the emission factor is determined by the ex-ante calculation the only data to be monitored is the Energy consumption in High Pressure Pumps with HV-VFD, as only plant devices affecting emission reductions.
This Energy consumption will be collected as part of normal plant operations, and will be checked against electricity supplier's receipts. The High Pressure Pump consumption is recorded continuously, and these data will be consulted yearly in the large-scale, distributed measurement and control system installed in the plant (SCADA). From these data will be calculated the energy savings annually, comparing them with the energy consumtion in the baseline.

2. Processing and managing structure
In order to insure the monitoring has been established the processing and managing structure as shown in Figure, which identified the staffs for data collection and preservation.



3. Data monitoring

The data will be archived electronically, by the

4. Quality Control

Quality control will be carrying out as indicates in Quality Control Plan's respective procedure, according to ISO 9001

5. Training program

Training program will be carrying out as indicates in Quality Control Plan's respective procedure, according ISO 9001

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

>>

Date of completion of the current version of baseline study and monitoring methodology: 07/12/2007

The name of the responsible person/entity:

Mr. Antonio Marín, Zero Emissions Technologies, SA.
Avda. De la Buhaira, 2 Sevilla.41018, Spain.
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SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
2008, August

C.1.2. Expected operational lifetime of the project activity:

>>
First 25 years in DBOOT, rest unknown

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

Not applicable

C.2.1.1. Starting date of the first crediting period:

>>
Not applicable

C.2.1.2. Length of the first crediting period:

>>
Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
2008, October

C.2.2.2. Length:

>>
10 years

SECTION D. Environmental impacts

>>

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

To predict the cause-condition-effect-relationship on the environment, an Environmental Impact Assessment (EIA)[4] study was conducted for the Desalination Plant.

The EIA study helps in justifying a project's sustainability plus provides with mitigation and management plan to abate the negative impact and enhance the positive ones. Thus EIA study is obligatory under Indian government policy under the Environmental (Protection) Act 1986 and the notification promulgated under it on 27 January 1994.

The proposed project related activities are mainly concerned with the marine environment; therefore a marine EIA study is essential. Also a "Terrestrial Environmental Management Report"[5] has been prepared, which presents the supplementary information on the environmental studies relating to the terrestrial aspects: i) socio-economic aspects, ii) air environment, iii) water environment, iv) noise environment, v) flora & fauna, vi) risk analysis and vii) environmental management plan.

The EIA report can be verified by the Designated Operational Entity.

Also, it may be noted that there are no trans-boundary impacts due to this project activity.

The marine EIA report and "Terrestrial Environmental Management Report" are provided in Enclosure II.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

No environmental impacts have been considered significant. (See enclosure II)

[4] By Indomer Coastal Hydraulics (P) Ltd.

[5] By Indomer Coastal Hydraulics (P) Ltd.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

Since the project activity implementation involves a set of installations in the Desalination Plant (not requiring major transportation or other energy inputs), and is relatively small scale it has no significant negative environmental impacts to noise, air or water pollution outside the facilities, therefore comments from the local population is not necessary.

The main stakeholders of the project activity are the management representatives who were actively a part of decision-making. The other stakeholders are the employees of the organization who work in the plant.

Although such in-house energy efficiency measures adopted by a plant does not demand an elaborate stakeholder consultation process, the project proponent has involved its employees at all levels in order to ensure proper understanding of the effects of the project activity. The benefits from such activity have also been transparently shared with the supply chain and shareholders. For this purpose, a Questionnaire has been elaborated and distributed between several employees, in order to know their point of view about the energy efficiency measures.

E.2. Summary of the comments received:

>>

The energy efficiency project does not have any negative impact. Instead, the emission from the captive power plant has also been reduced and local environment has been improved.
The questionnaire filled and signed by employees will be available for Designed Operational Entity's request.

E.3. Report on how due account was taken of any comments received:

>>

All comments received by the stakeholders were positive. No suggestions concerning the project activity were received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in project activity.

Annex 3

BASELINE INFORMATION

CENTRAL ELECTRICITY AUTHORITY: CO2 BASELINE DATABASE

VERSION	**3.0**
DATE	**15 December 2007**
BASELINE METHODOLOGY	**ACM0002 / Ver 07**

Simple Operating Margin (tCO2/MWh) (incl. Imports)

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
North	0.98	0.98	1.00	0.99	0.98	1.00	1.00
East	1.22	1.19	1.17	1.20	1.17	1.13	1.09
South	1.02	1.00	1.01	1.00	1.00	1.01	1.00
West	0.98	1.01	0.99	0.99	1.01	1.00	0.99
North-East	0.74	0.71	0.74	0.74	0.90	0.70	0.70
India	1.01	1.02	1.02	1.02	1.02	1.02	1.01

Build Margin (tCO2/MWh) (not adjusted for imports)

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
North					0.53	0.60	0.63
East					0.90	0.97	0.93
South					0.70	0.71	0.71
West					0.77	0.63	0.59
North-East					0.15	0.15	0.23
India					0.69	0.68	0.68

Combined Margin in tCO2/MWh (incl. Imports)

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
North	0.76	0.76	0.77	0.76	0.76	0.80	0.81
East	1.06	1.05	1.04	1.05	1.04	1.05	1.01
South	0.86	0.85	0.86	0.85	0.85	0.86	0.85
West	0.87	0.89	0.88	0.88	0.89	0.82	0.79
North-East	0.44	0.43	0.44	0.44	0.52	0.42	0.46
India	0.85	0.86	0.86	0.86	0.86	0.85	0.84

ELECTRICITY TRANSFERS

(Net, in GWh)

Year 2006-2007 (Provisional)

From / To	Northern	Eastern	Southern	Western	North-Eastern	Bhutan	Nepal
Northern		-6,477.3	0.0	-196.3	0.0	0.0	61.9
Eastern	6,477.3		1,551.7	6,741.2	92.1	-2,957.4	145.6
Southern	0.0	-1,551.7		3,928.2	0.0	0.0	0.0
Western	196.3	-6,741.2	-3,928.2		0.0	0.0	0.0
North-Eastern	0.0	-92.1	0.0	0.0		0.0	0.0
Bhutan	0.0	2,957.4	0.0	0.0	0.0		0.0
Nepal	-61.9	-145.6	0.0	0.0	0.0	0.0	
Net imports	6,611.7	-12,050.4	-2,376.5	10,473.1	92.1	-2,957.4	207.5
Total Imports	6,673.6	2,957.4	1,551.7	10,669.4	92.1	0.0	207.5

BASE PARAMETERS AND ASSUMPTIONS

Fuel Emission Factors (EF) (Source: Coal/Lignite - Initial National Communication, Gas/Oil/Diesel/Naphta - IPCC 2006, Corex - own assumption)

	Unit	Coal	Lignite	Gas	Oil	Diesel	Naphta	Corex
EF based on NCV	gCO2 /MJ	95.8	106.2	56.1	77.4	74.1	73.3	0.0
Delta GCV NCV	%	3.6%	3.6%	10%	5%	5%	5%	n/a
EF based on GCV	gCO2 /MJ	92.5	102.5	51.0	73.7	70.6	69.8	0.0
Oxidation Factor	-	0.98	0.98	1.00	1.00	1.00	1.00	n/a
Fuel Emission Factor	gCO2 /MJ	90.6	100.5	51.0	73.7	70.6	69.8	0.0

n/a = not applicable (i.e. no assumptions were needed)

Assumptions at Station Level (only where data was not provided by station)

	Unit	Coal	Lignite	Gas-CC	Gas-OC	Oil	Diesel-Eng	Diesel-OC	Naphta	Hydro	Nuclear
Auxiliary Power Consumption	%	8.0	10.0	3.0	1.0	3.5	3.5	1.0	3.5	0.5	10.5
Gross Heat Rate	kcal /kWh (gross)	2,500	2,713	0	3150	0	1,975	3,213	0	n/a	n/a
Net Heat Rate	kcal /kWh (net)	2,717	3,014	0	3,182	0	2,047	3,330	0	n/a	n/a
Specific Oil Consumption	ml /kWh (gross)	2.0	3.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GCV	kcal /kg (or m3)	3,755	n/a	8,800	n/a	10,100	10,500	10,500	11,300	n/a	n/a
Density	t /1,000 lt	n/a	n/a	n/a	n/a	0.95	0.83	0.83	0.70	n/a	n/a
Specific CO2 emissions	tCO2 /MWh	1.04	1.28	0.00	0.68	0.00	0.60	0.98	0.64	n/a	n/a

Assumptions at Unit Level (by capacity; only for units in the BM, where data was not provided by station)

Coal	Unit	67.5 MW	120 MW	200-250 MW	500 MW
Gross Heat Rate	kcal /kWh	2,750	2,500	2,500	2,425
Auxiliary Power Consumption	%	12.0	9.0	9.0	7.5
Net Heat Rate	kcal /kWh	3,125	2,747	2,747	2,622
Net Efficiency	%	28%	31%	31%	33%
Specific Oil Consumption	ml /kWh	2.0	2.0	2.0	2.0
Specific CO2 Emissions	tCO2 /MWh	1.19	1.05	1.05	1.00
Lignite	Unit	75 MW	125 MW	210/250 MW	
Gross Heat Rate	kcal /kWh	2,750	2,560	2,713	
Auxiliary Power Consumption	%	12.0	12.0	10.0	
Net Heat Rate	kcal /kWh	3,125	2,909	3,014	
Net Efficiency	%	28%	30%	29%	
Specific Oil Consumption	ml /kWh	3.0	3.0	3.0	
Specific CO2 Emissions	tCO2 /MWh	1.32	1.23	1.28	
Gas	Unit	0-49.9 MW	50-99.9 MW	>100 MW	
Gross Heat Rate	kcal /kWh	1,950	1,910	1,970	
Auxiliary Power Consumption	%	3.0	3.0	3.0	
Net Heat Rate	kcal /kWh	2,010	1,969	2,031	
Net Efficiency	%	43%	44%	42%	
Specific CO2 Emissions	tCO2 /MWh	0.43	0.42	0.43	
Diesel	Unit	0.1-1 MW	1-3 MW	3-10 MW	>10 MW
Gross Heat Rate	kcal /kWh	2,350	2,250	2,100	1,975
Auxiliary Power Consumption	%	3.5	3.5	3.5	3.5
Net Heat Rate	kcal /kWh	2,435	2,332	2,176	2,047
Specific CO2 Emissions	tCO2 /MWh	0.72	0.69	0.64	0.60
Naphta	Unit	All sizes			
Increment to Gas Heat Rate	%	2%			
Gross Heat Rate	kcal /kWh	0			
Auxiliary Power Consumption	%	3.5			
Net Heat Rate	kcal /kWh	0			
Specific CO2 Emissions	tCO2 /MWh	0.00			

Annex 4

MONITORING INFORMATION