Review Comment No 1

Application of methodology- AMS III B "switching fossil fuels" is not an appropriate methodology for the fuel switch measure 'natural gas to hydrogen', as hydrogen is not a fossil fuel but simply represents an energy carrier that is normally produced by means of natural gas or fuel oil.

Response No. 1

The applicability conditions of AMS III B version 9 dated 28 July 2006 and corresponding project conditions are presented below:

S.No	Applicability Condition of AMS III B	Relevance to Project Activity
1.	This category comprises fossil fuel switching in existing industrial, residential, commercial, institutional or electricity generation applications.	The proposed project activity involves switching of fuel from natural gas to hydrogen (refer note below explaining the role of hydrogen as fuel in the proposed project activity) at the CCU-II unit of GACL's complex in Vadodara.
2.	Fuel switching may change efficiency as well. If the project activity primarily aims at reducing emissions through fuel switching, it falls into this category.	The basic aim of the activity is to change from fossil fuel (NG) to hydrogen gas.
3.	If fuel switching is part of a project activity focused primarily on energy efficiency, the project activity falls in category II.D or II.E.	The project activity is not a part of an energy efficiency programme and targets fuel switch.
4.	Measures shall both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.	The fuel switch measures at GACL shall both reduce anthropogenic emissions by sources and directly emit 4507 tCO2 annually i.e. less than 15 kilotonnes of carbon dioxide equivalent annually.
5.	This category is applicable for project activities resulting in annual emission reductions lower than 25,000 ton CO_2e. If the emission reduction of a project activity exceeds the reference value of 25,000 ton CO_2e in any year of the crediting period, the annual emission reduction for that particular year is capped at 25,000 ton CO_2e.	As above.

Hydrogen as fuel

The project activity has been carried out at the caustic soda and sodium cyanide manufacturing plants of GACL at Vadodara. The caustic soda is produced at GACL through the electrolysis process. The main raw materials for this process are electricity, salt (Sodium Chloride, NaCl) and water. The electricity used is a combination of captive generated NG based power, power procured from NG based power plant of GIPCL and purchased from state grid, as the case may be.

Since hydrogen is an energy carrier, not an energy source, it must be produced. In the proposed CDM project activity, hydrogen gas is one of the co products generated during electrolysis along with chlorine. The input energy in form of electricity is utilized in electrolysis for the electrolytic decomposition and residual energy is available in the hydrogen. Hydrogen gas releases energy when burned in presence of oxygen and thus transmitting the energy imbibed from electricity and heat of reaction.

In the absence of the proposed CDM project activity, the same amount of heat would be generated by utilization of NG. In keeping with all the details provided above and in the absence of any other methodology addressing switching from fossil fuel, AMS III B was found to be applicable to the proposed CDM project activity.

Review Comment No 2

There is a different grid emission factor mentioned in the Validation Report as compared to the factor outlined in the PDD.

Response No. 2

The values of emissions factors and their reference in both PDD and the validation report are presented in the table below:

Parameter	Value and reference in	
	PDD	Validation report
Grid emission factor using combined margin	1136 tCO_2/GWh (Appendix III on page 34)	1136 tCO_2/GWh (page 8)
Emission factor for self generation of power	460.12 tCO_2/GWh (Appendix III on page 34)	460.12 tCO_2/GWh (page 9)
Ratio of grid power and self generated power	Percentage from Dahej 0.575259209 Percentage from GEB 0.424740791 (Appendix III on page 34)	Not provided specifically
Emission factor based on above ratio of grid power and self generated power	747.1989266 tCO_2/GWh (Appendix III on page 34)	Not provided specifically

Review Comment No 3

The additionality of the project-The validity of the arguments related to the investment barriers

Response No. 3

The various arguments on investment barriers as presented in the PDD have been further explained in the subsequent sections.

Energy Efficiency Measures:

The details of investment made by GACL on all the projects under the category IIC and II D are provided in table below.

Equipment	Expenditure (Million INR)	Year of investment
Tray dryer	7.66	2002

DCS control system	3.55	2005
Electrolysers	79.58	2004
Motor replacement	0.70	2004
Total Cash Outflow	90.79	

The total investment incurred in this process is nearly INR 91 million. The quantum of investment and efforts made by GACL to save marginal amounts of energy is mainly with the view of reducing global warming and GhG emissions reduction.

The pay back period for the project activity has been found to be more than four and a half years. Detailed calculation is given in table below.

Parameter	Value	Unit
Total Energy Savings	11.21	GWh
Total Energy Savings	13250000	KWh
Cost of Electricity	2	Rs/KWh
Total savings	26500000	Rs
	22.5	Million
Principle Investment	90.79607	Million
Investment rendered lost after accounting for depreciation of replaced/removed equipments	20	Million
Total investment	110.7961	Million
Total returns/savings	22.5	Million
Pay back period	4.92	years

The NPV for the project activity is also found to be negative. The calculations are given in table below:

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Cash out flow										
Capital investment	90.80									
Investment rendered lost after accounting for depreciation of replaced/removed equipments	22.00									
Total outflow	112.80									
Loss of opportunity cost										
Intrest @9% as per RBI1 interest rate against the amount that has been invested	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17
Cash inflow										
Cash inflow due to	22.42	22.42	22.42	22.42	22.42	22.42	22.42	22.42	22.42	22.42

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
electricity saving										
	-98.55	14.25	14.25	14.25	14.25	14.25	14.25	14.25	14.25	14.25
NPV	-13.13									

Thus, the project activity is not financially attractive without CDM revenue

Fuel Switch Measures:

Hydrogen gas, a co-product of the caustic soda process, has demand by other industries in the region for hydrogenation purpose. The price at which hydrogen is being sold by GACL is:

1. Supply of Hydrogen to GEB @ Rs.19 Nm^3
2. Supply of Hydrogen to M/s. Jayant Agro @ Rs.14/ Nm^3
3. GACL has signed a contract with M/s .Luna Chemicals @ Rs.6.25/Nm^3 (for bulk sale in Dahej)

The quantity of Hydrogen Gas to M/s. GEB is in the range of 1000 Nm^3/day, to M/s. Jayant Agro in the range of about 5000 Nm^3/day & contract amount with M/s. Luna Chemicals is around 50000 Nm^3/day. Based on this the average price of Hydrogen gas has been taken as Rs.7.26 per Nm^3.

Natural Gas (NG) is purchased by GACL from GAIL at the cost of Rs 3.8/S m^3.

The requirement of quantity of hydrogen as a replacement fuel is 3.62 times than that of NG (105 Sm^3 of NG or 380 Nm^3 of Hydrogen is required for the production of 1 MT of Caustic Soda flakes).

Caustic Flakes Project	95 MT/day
Operation during year	360 days
CSF Production in a year	34200 MT/day
NG Requirement	105 SCM / MT of CSF
Total NG Requirement/year	105 x 34200 = 3591000 SCM
Equivalent Cost	INR 13.64 Million
Hydrogen consumption	380 Nm3/ MT of CSF
Total hydrogen consumption/year	12996000 Nm3 /year
Equivalent Hydrogen Sale Value	INR 94.35 Million

There is clearly an opportunity cost associated with utilization of Hydrogen as fuel instead of NG. Thus, by replacing the fuel from NG to hydrogen, GACL is losing of INR 50 million per year.