NUMALIGARH REFINERY LIMITED

Golaghat Distt., Guwahati (Assam)

Unit Profile

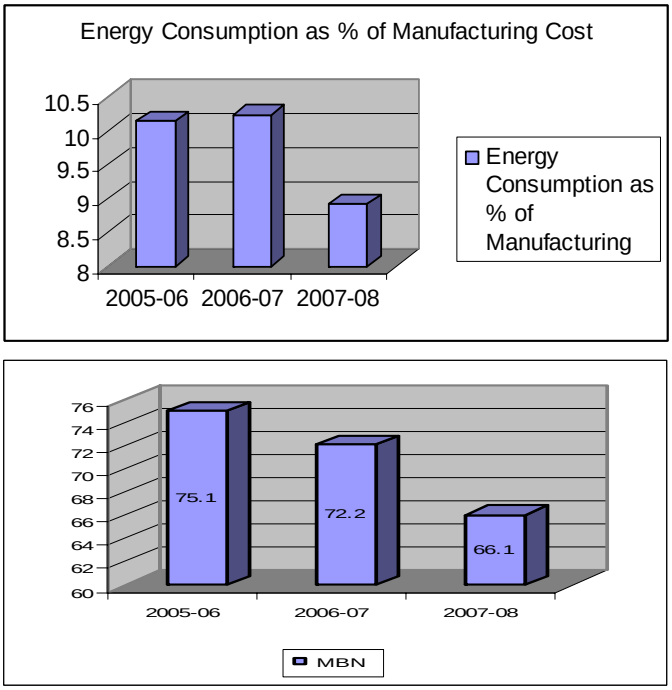
Numaligarh Refinery, a subsidiary of Bharat Petroleum Corporation Limited is designed to process 3.0 MMTPA of crude oil with the configuration of Crude Distillation Unit, Delayed Coker Unit, Hydrocraker Unit, Hydrogen Generation Unit, Sulphur Recover Unit, Coke Calcinations Unit & Marketing Terminal (NRMT). In order to value addition for the currently available surplus Naphtha as well as to meet the market demand of MS in North- Eastern, Eastern and Northern regions, Motor Spirit Plant has been recently set up. The main products of Numaligarh Refinery are Euro-II/Euro-III High Speed Diesel High Speed Diesel, Euro–II/III Motor Spirit, Liquefied Petroleum Gas, Aviation Turbine Fuel, Superior Kerosene Oil, Naphtha, Fuel Oil, Raw petroleum Coke/Calcined Coke etc.

Energy Consumption

Numaligarh Refinery consumes various types of fuel viz. refinery fuel gas and low sulphur internal fuel oil in furnaces/boilers. Naphtha is consumed in Captive Plant for power generation and in Hydrogen unit for Hydrogen generation. Many numbers of energy conservation schemes has been implemented in Numaligarh Refinery contributing a lot for reducing consumption of fuel.

DESCRIPTION		UNIT	2005-2006	2006-2007	2007-2008
Annual Production		MT	1918876	2226735	2301592
Specific Energy Consumption		MBN	75.4	72.5	66.1
Energy Cost as % of Manufacturing Cost	Electricity	-	3.19%	3.02%	2.75%
	Liquid Fuel	-	3.16%	2.95%	2.24%
	Refinery Gas	-	3.79%	4.26%	3.93%
	Total		10.14 %	10.23%	8.92%
F& L%			10.37	10.53	10.24

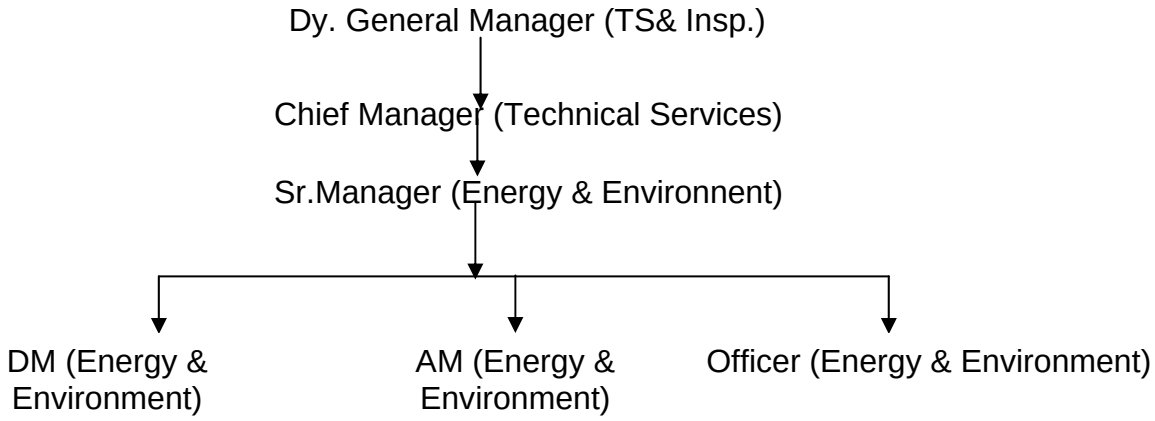
The energy consumption in refinery is reported in terms of % Fuel & Loss on crude and MBTU/BBL/NRGF (MBN), where the term MBTU refers to total heat value of fuel and loss in thousand BTU, BBL refers to barrel of crude processed and NRGF is a derived factor that depends upon actual intake in both primary and secondary processing units as per industry standard. The % fuel & loss, MBN and energy cost as % manufacturing cost for last three years is as given below: The specific energy consumption is gradually improving over the last three years, graphical representation of which is given below.



Energy Conservation Commitment, Policy and Set up

Numaligarh Refinery has the highest concern and commitment for conservation of Energy and preservation of Environment. Numaligarh Refinery is having commitment for compliance of all the statutory regulations and acts pertaining to energy conservation and to attain sustained excellence in the field of energy management and energy efficiency. The Energy Management Policy of the refinery has been approved by the board of directors of the refinery which consists of adopting and nurturing Energy Efficient and environment technologies and undertaking social responsibility to educate, share and promote energy and environment aspects with others in the vicinity.

A fully functional, dedicated and separate Energy & Environment Cell manned by qualified engineers, headed by a Chief Manager and reporting to Dy. General Manager (I/C, Refinery) is continuously working for continuous improvement, monitoring of energy and environment related activities.



Energy Conservation Achievements

The major energy conservation projects implemented at Numaligarh Refinery are as given below:

Reduction of heat loss in Coke Chamber in Delayed Coker Unit

While carrying out thickness gauging of the Coke chamber in DCU , it was observed insulation of the coke chamber had decreased in thickness and in certain cases crossed the minimum allowable limit after prolong operation of almost 10 years. Based on the trend of decrease of the thickness/damage of insulation a decision was taken for replacement of insulation of both chamber online one by one .After online replacement of both chamber insulation completely with 250mm mineral wool, heat loss has been significantly improved. Improvement in the operating performance of Delayed Coker Unit has been achieved as follows:

Sl. No.	Observations	Before replacement	After replacement	Remarks
1	Chamber Feed line temperature,(°c)	484 – 487	493 – 494	Transfer line heat loss minimized
2	Chamber Skin temperature, (°c)	415-420	445-455	Cracking takes place sufficiently at high temperature.
3	Vapour heating period, (hr)	5-5.0	3.5-4.0	Loss minimized
4	Slop generation ,(m3/day)	60-70	30-35	Slop generation minimized by early diversion of Vapor and liquid to CC-02.
5	Gas generation	Regularly LPG make up in FG network during vapor heating period.	Sufficient gas generated and gas diverted within 40-50 min of vapor heating start.	With minimum time gas diverted, needn't to take LPG backup in FG network.
6	LPG yield (%)	4.0-4.10	4.9-5.0	Design 4.95 %

7	RPC Bulk density, (gm/cc)	0.750	0.8010	RPC Hard ness increased.
8	Reduction of power consumption	Running EA-28 for more time Running of PA-12A/B for 5.5 - 6.0.hrs.	EA-28 can be stopped within 1.25-1.30hrs PA-12A/B can be stopped within 4.5-5.5 hrs.	After liquid diversion EA-28 (6 nos. fin fan) can be stopped within 1.25-1.30hrs, earlier it took 2-2.5 hrs for liquid diversion. With reduction of Vapor heating time power consumption reduced.
9.	Reduction of Fuel (% of feed)	>4.5	<4.2	Preheat outlet temp and Fractionator column temperature profile is not reduced so much as it regains its Temp very soon after diversion of vapor & liquid.

By providing new in the furnace to coke chamber transfer lines as well as over the coke chamber, a substantial saving of energy 47418 Million Kcal per annum has achieved. Annual energy saving of Rs. 18.32 crores investing a capital cost of Rs. 10 lakhs has been realized.

Energy Conservation Plans and Targets

- Installation of 12 MW Steam Turbo Generator (STG) for Captive Power Generation by recovery and utilization of the waste (thermal & pressure) of HP steam .The project will be implemented by January, 2008.
- Use of natural Gas in GTG and Hydrogen Unit by replacing Naphtha.
- Utilization of very low pressure hot well gases from VDU to CDU furnace is under implementation.
- Phase wise implementation of Advanced Process Control (APC) in the remaining process plants are in progress (already implemented in CDU/VDU during 2004-05).
- Implementation of innovative technology for use of O2 rich waste air stream available from N2 plant as enrich air in Sulfur Recovery Unit by replacing conventional use of process air.
- Substantial energy saving by cleaning of Fin Fan coolers' finned tubes in Hydrocracker Unit by application of Foam cleaning technique was achieved. Cleaning of Fin Fan coolers of other units also by similar cleaning method is planned in RTA 2008.
- Replacement of conventional lighting fixtures by more energy efficient fittings.
- Improvement of insulation effectiveness of steam lines and heaters.
- Implementation of LDAR (Leak Detection and Repair Program).
- Installation of Flare Gas Recovery System for recovery and reuse of refinery waste gas going to flare.

Environment and Safety

Numaligarh Refinery is situated near ecologically sensitive zone. The requirement of safety and environment is incorporated during design and construction stage itself, for new facilities. All relevant national and international standards like ISI, ASME, OISD, API, NFPA etc. are taken into consideration at the design stage. Requirements of various statutory rules and regulations like Factories Act, Petroleum Act and Rules, Boiler Rules, Environment and pollution Regulations etc. are complied with. NRL Management accords top most priority to Health, Safety and Environment Issues. The Environment & Safety performance is reviewed by the apex committee once in two months which is chaired by Director Technical of the refinery. Besides unit level and area level safety committees meet every month to review the safety performance of respective unit/area, the environment and safety issues are also reviewed in functional co-ordination meeting chaired by the Managing Director every month.

Following are the some of the Initiatives taken by NRL for environment protection since its inception:

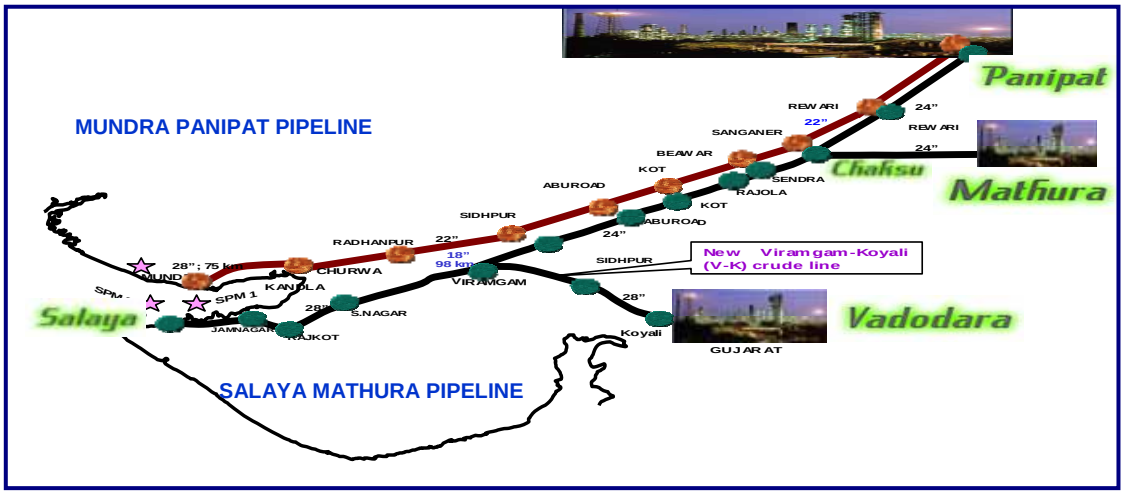
- Selection of process technology/equipments made on basis of special care for environment protection.Hyydrocracker technology has been incorporated to produce low sulphur products
- Sulphur Recovery unit has been incorporated inspite of low sulphur processing crude.
- Sweet refinery gas/low sulphur naphtha is used as primary fuel resulting in low SO_2 emission to the atmosphere.
- Low NOx burners installed in all the refinery furnaces to minimize pollution because of nitrogen dioxide.
- Stack heights have been kept at 60/77 mtrs to minimize pollution concentration at ground level.
- Hazardous solid waste generated in the refinery is disposed off by Secured Landfill technology.

INDIAN OIL CORPORATION LIMITED - PANIPAT REFINERY

Panipat (Haryana)

Unit Profile

Panipat refinery is the 7th refinery of Indian Oil Corporation. It is located about 20 kms from Panipat city and 100 km from Delhi. Panipat Refinery built at the cost of Rs. 3868 crore (including Marketing and pipelines installation) with an installed capacity of processing 6 million metric tonnes per annum of crude oil in the year 1998. Further, Refinery capacity expanded to 12 MMTPA in 2006 at a cost of Rs. 4165 crore. It is India's one of the most modern refinery with global technologies from IFP, France, Haldor Topsoe Denmark, UNOCAL/ UOP, Stone & Webster, ABB Lummus USA. The refinery receives crude oil through two pipelines – Salaya-Mathura Panipat Pipeline and Mundra Panipat Pipeline.



The Refinery produces cooking gas (LPG), Petrol, jet fuel, kerosene & Diesel apart from other products such as Naphtha, Bitumen, HPS and MTO. For environment protection & conservation, the refinery has also commenced production of BS-II and Euro-III low sulphur diesel and petrol.

To meet the demand of various petroleum products, the refinery has a number of process units along with captive power plant, utilities block and effluent treatment facilities. The various units of the refinery are:

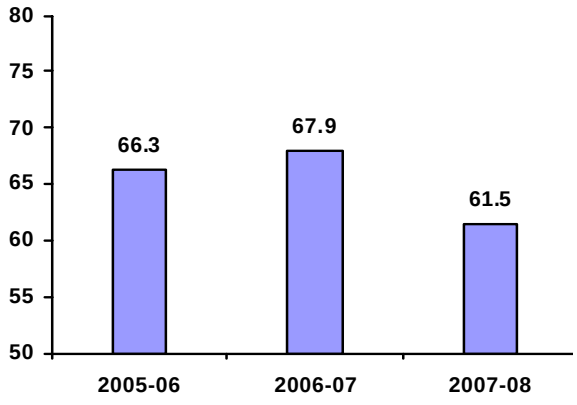
- AVUs (Atmospheric & Vacuum Distillation Units) : (6.0 x 2 = 12 Million Metric Ton Per Annum): Crude oil distillation / fractionation for further processing in secondary units
- HGUs (Hydrogen Generation Units – 1 old + 2 new) : (0.038 + 70 x 2 MMTPA): Hydrogen generation for processes requiring hydrogen
- CCRU (Continuous Catalytic Reforming Unit): (0.64 MMTPA): For improving octane number of petrol component. This process eliminates requirement of environmentally hazardous TEL (Tetra Ethyl Lead) blending in petrol.
- RFCCU (Resid Fluidized Catalytic Cracking Unit) : (0.85 MMTPA): Catalytic cracking of heavy intermediate stocks for production of lighter products viz. LPG, Petrol, Diesel components
- BBU (Bitumen Blowing Unit): (0.5 MMTPA): For production of Bitumen.
- VBU (Visbreaker Unit) : (0.4 MMTPA): Thermal cracking of Vacuum Residue is carried out for viscosity reduction and production of HPS Fuel
- OHCU (Once through Hydrocracker Unit) : (1.6 MMTPA) and HCU (MMTPA) : (1.7 Million Metric Ton Per Annum) : Heavy petroleum stock is subjected to hydrocracking for production of lighter products viz. LPG, Petrol, Diesel components
- DHDS (Diesel Hydro desulphurization Unit): (0.7 MMTPA) and DHDT (Diesel Hydrotreating Unit) (3.5 MMTPA): For removal of sulphur components and production of low sulphur environment friendly Diesel
- DCU (Delayed Coking unit) (2.4 MMTPA): Thermal cracking of Vacuum Residue is carried out for production of Distillates and HPS Fuel

Energy Consumption

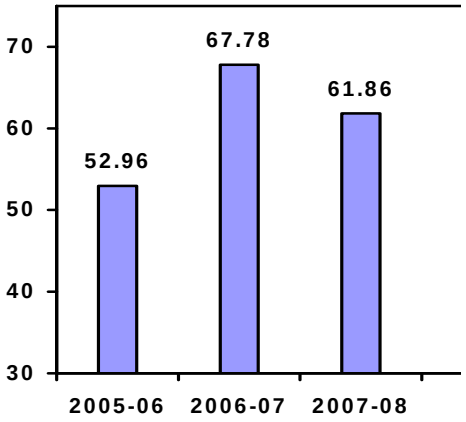
The refinery primarily consumes own generated Fuel Oil (IFO, LDO & Naphtha) and Refinery off-gas to meet its entire energy demand including power generation at its captive power plant. Power import is nominal. The total energy consumption is monitored on regular basis. Energy conservation receives top priority at Panipat refinery. The Top Management commitment to perform and outpace the international pacesetter refineries has percolated down to the line staff.

As a result of various ENCON & other operational improvements, the total energy cost of the refinery have steadily declined from a level of 8.5% in 2001-02 to the current level of 6.4% of the total manufacturing cost including crude oil cost. Specific electrical energy consumption has come down from 55.6 KWh/ MT crude processed in 2001-02 to 52.96 KWh/MT crude processed in 2005-06. Similarly, thermal energy consumption has come down from 0.738 MMKCal/ MT crude processed in 2001-02 to 0.709 MMKCal/MT crude processed in 2005-06. However, during 2006-07, both electrical and thermal energy consumption has increased due to addition of new process units, boilers, gas turbines and other associated facilities under refinery expansion and again come down in 2007-08.

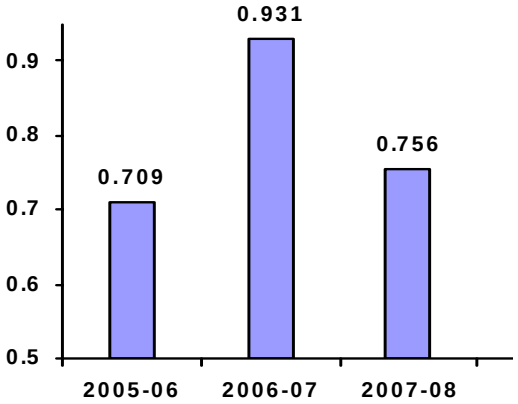
Energy & loss performance in terms of MBN (MBTU/BBL/NRGF – the measure extensively used in crude oil refining sector for energy performance evaluation) has come down from 81 in 2002-03 to 61.5 in 2007-08.



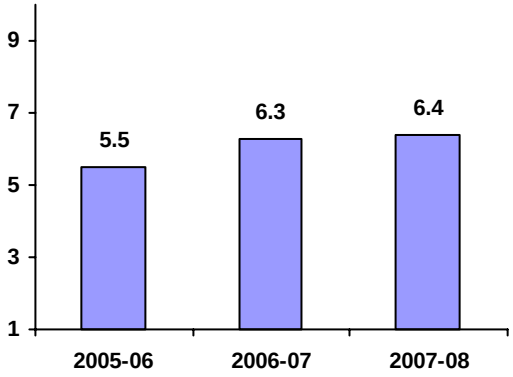
ENERGY + LOSS PERFORMANCE: MBN (MBTU / BBL /NRGF)



SPECIFIC ELECTRICITY CONSUMPTION: KWH / MT CRUDE PROCESSED



SPECIFIC THERMAL ENERGY CONSUMPTION: MMKCal / MT CRUDE PROCESSED



ENERGY COST AS % OF MANUFACTURING COST

Energy Conservation Commitment, Policy and Set up

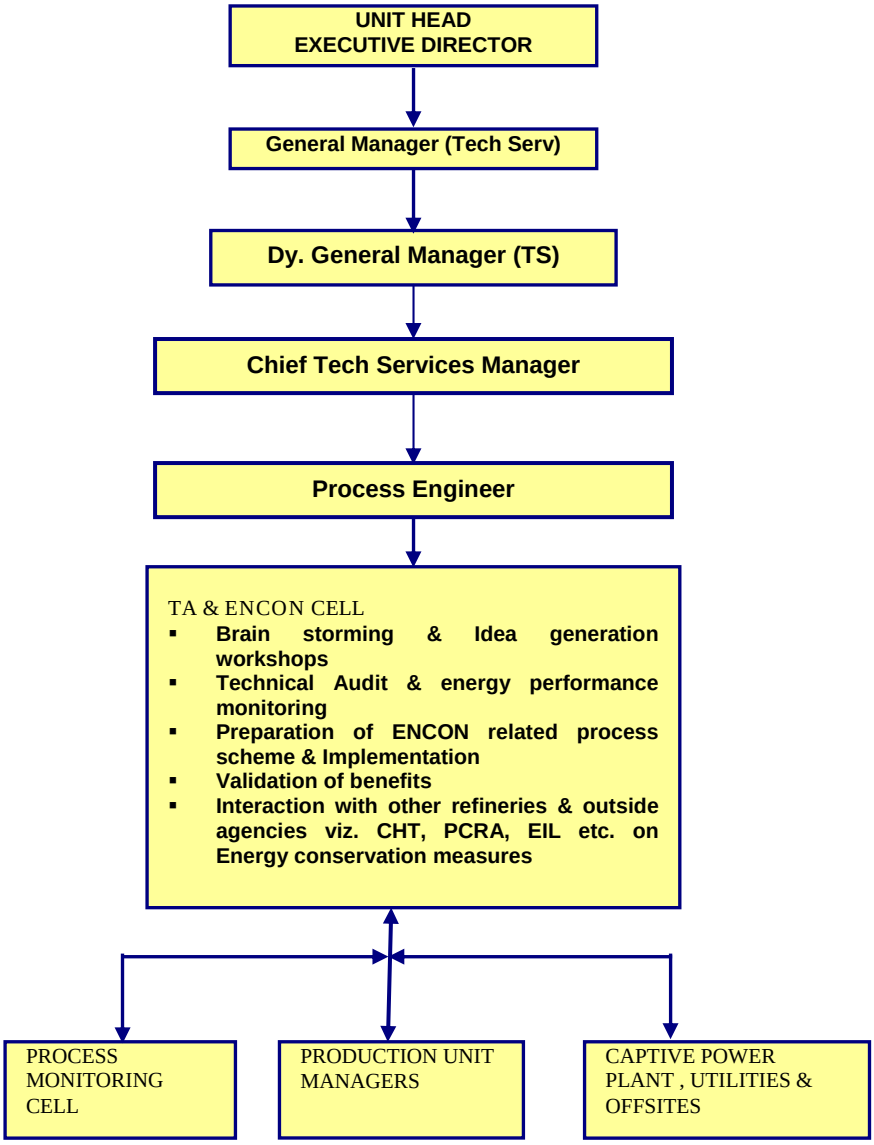
ENERGY POLICY

To be a World Class Performer in
Energy Management by

- Adopting energy efficient and environment friendly technologies.
- Benchmarking our performance with the best in the world and endeavoring to be ahead.
- Promoting use of renewable sources of energy.
- Fostering a culture of participation and innovation amongst stake holders for continual improvement in energy conservation.
- Propagating the message of avoiding wastage of energy to the community.

Indian Oil Corporation Limited

Energy Conservation Team Structure



Energy Conservation Achievements

Details of Schemes Implemented in 2007-08:

1. Scheme: Routing Of Coker Blow Down Overhead Vapours to Wet Gas Compressor

Background:

Blow down of coke drums is carried out during cyclic operations in Coker unit of Panipat Refinery. Overhead vapours coming out of blow down overhead separator had to be routed to flare. Although there was a provision of vapour recovery by manual routing of these vapours to WGC suction, the line up required was very delicate and balanced due to manual operation of four valves to prevent backflow from WGC suction to flare.

Observation:

It was observed that the following modification will facilitate the routing of Coker Blow down Overhead Vapours to Wet Gas Compressor in stead of flaring:

- Routing the recovery line from upstream of PV5802 instead of downstream and providing a control valve.
- Provision of NRV to prevent backflow thereby saving WGC tripping on account of low suction pressure.

Technical / Financial Analysis:

With the modification, 10 Tons per day Flaring was reduced and FG generation increased.
Equivalent fuel savings of about 37290 Million kcal per year.

Impact of Implementation:

Implementation of modification scheme to utilize 10 MTPH gas resulted in **savings of about 3805 MT fuel per year.**
Financial Savings: Rs. 7.40 Crore per year

2. Scheme: Provision of Zero Leak Slab Gate Valves with electrical actuators for Naphtha and MS Tanks Manifolds

Background:

For transfer of Naphtha and MS from refinery tanks thru' Pipelines to other marketing locations, blinding and de-blinding operation for positive isolation leads to hydrocarbon losses at the manifold.
Technical / Financial Analysis:
Hydrocarbon savings = 595 MT.
Equivalent fuel savings = 6000 Million Kcal/Year.
Impact of Implementation:
Financial Savings: Rs. 119 Lac per year

3. Scheme: Provision of CDU-1 reflux drums overhead gas routing to RFCCU WGC to reduce loss of gas to flare

Background:

The CDU-1 reflux drum pressure control was split range type with fuel gas back up facility at low-pressure condition and flaring the excess gas during high-pressure condition. The reflux drum pressure is maintained between 2.2 – 2.6 kg/cm2g.

Observation:

During summer season, when ambient temperature is high and if overhead air fan coolers are having constraints, the reflux drum over pressure flaring occurs intermittently. To avoid this flare loss, third pressure control valve placed with intermediate pressure set point to route the gas to WGC in RFCCU. This modification facilitated saving of lighter gas which otherwise was getting lost to flare.

Technical / Financial Analysis:

Quantity saved by routing to WGC = 600 kgs/hr.
Equivalent Fuel savings: 52580 MKcal per year.
Financial Savings: Rs. 10.47 Crore per year

4. Scheme: Optimization of steam turbine operations for ID and FD fans of the CDU-2 by closing secondary port in the turbine driven pump.

Background:

In line with earlier experience in new Hydrogen Unit, in CDU-2 unit also, secondary ports in the turbine of ID/FD fans were closed. Steam consumption by these drives are higher than anticipated and the efficiency was comparatively low.

Observation:

The closing of the optional hand valve (jet valves) located on the outside of the turbine casing in CDU-2 ID/FD fans were gradually isolated and the steam load came down substantially by 5 MT/ Hr.

Technical / Financial Analysis:

After adjusting steam turbine operations, steam saved: 5 MT/ hr.
Equivalent fuel saving = 26670 Mkcal/Yr

Impact of Implementation:

Steam optimization resulted in 2667 MT per year fuel saving.
Financial Savings: Rs. 5.29 Crore per year.

5. Scheme: Optimization of PREP Process cooling tower operation by stopping one pump and 3 nos. overhead induced draft fans

Background:

PREP process cooling tower is having 7 CW pumps and each pump has a capacity of 4000 M^3/hr. The design circulating water flow is 20000 M3/hr, which is met by running 5 pumps continuously. This cooling tower caters to the requirement of all the PREP units like AVU II, HGU II & III, DHDT, Hydro cracker, DCU and NSU II. Since commissioning of the PREP Units, 5-6 pumps were run to maintain the cooling water requirement of these units.

Observation:

It was observed that sufficient margin existed w.r.t. the approach temperature between the supply and return header. All coolers and condensers were observed for temperature approaches and wherever a margin was observed the cooling water return line isolation valve was throttled a bit. Barring peak summer months, the cooling tower operations sustained with only four pumps in line and still a cooling water supply header pressure of 4.2 Kg/cm2g could be maintained, without affecting the operations of any of the process units.

Technical / Financial Analysis:

The savings in power consumption after stopping one cooling water pump and 3 overhead draft fans = 770 KWH
Total power saving: 4432 MWh/year

Impact of Implementation:

Financial Savings: Rs. 2.64 Crore per year

Energy Conservation Plans and Targets

Panipat refinery is committed to achieve international standards of excellence in energy consumption. The Refinery has following major plans for reduction of Energy Consumption:

Energy conservation measures (planned)	Anticipated savings in Energy		Approx. Investment (Rs. Lakhs)	Project commencement & completion year
	Energy value (MT Fuel/Yr)	Rs. Lakhs/Yr		
Enhancing capacity of WHB in SSRU (SRU/ SSRU segregation job)	2860	956	100	2008-09
Interconnection of PX PTA LP steam header to PREP SRU LP header	1540	515	10	2008-09
Low cost RFCCU revamp - Additional steam by Heat Recovery from bottom stream	2500	836	9021 *	2008-09
Secondary seal in floating roof tanks of MS & Naphtha	190	64	142	2008-09
Optimization in cooling tower operation by stopping three nos. cooling tower pumps each in PR, PREP and CPP.	3020	1010	0	2008-09
Installation of installation of Variable frequency Drives in CDU-2 Crude Feed Pumps	1210	405	500	2009-10
Flare gas recovery in PR+PX and PREP	5800	1940	2800	2009-10
Provision of Plug Valves/ Zero Leak Slab Gate Valves for HSD Tanks Manifolds	500	167	400	2009-10
Secondary seal in floating roof tanks of crude oil	115	38	130	2009-10
Replacement of gas AC compressor with Vapour absorbed Machine	870	291	484	2009-10
Total	18605	6222	13587	

* Total project cost including Encon.

Environment and Safety

Environment Management

Panipat Refinery's Environment Management System is accredited with ISO-14001 since 2001. Panipat Refinery bagged the Golden Peacock Award in 2000 and also in 2003 for Environment Management initiatives from the World Environment Foundation. Panipat Refinery is also maintaining zero discharge of treated effluent since inception. Extensive efforts have gone in for these distinct achievements which comprise

1. Measures Taken At Design Stage

- Provision of Tall Stacks (100 m and above) for better dispersion of pollutants
- Desulphurization of Fuel Gas
- Provision of 100 % Stand by Sulphur Recovery Unit with guaranteed 99 % recovery
- Provision of CO Boiler in RFCCU Unit
- Low Sulphur Fuel Oil use in Furnaces
- Provision of on line continuous Sulphur di oxide analyzers in major stacks of refinery.
- Establishment and commissioning of 10 continuous Ambient Air Monitoring Stations to monitor Ground level SO2 concentrations.
- State of art Effluent Treatment Plant with Physical , Chemical & Biological Treatment facilities
- Recycling, Reusing resulting zero effluent discharges refinery.

2. Actions Taken After Commissioning of the Refinery

- Zero Discharge of Treated Effluent: - To ensure zero discharge, it became imperative to reuse / recycle the treated effluent in our own refinery system right from the commissioning of refinery. Schemes were implemented and the reuse / recycle system further strengthened in the following areas :-

    1. Cooling tower water Make-up
    2. Fire Water Make-up
    3. Irrigation of Green Belt developed and maintained by the Refinery.

4. Treated Effluent reuse for solution preparation in Wastewater Treatment Plant.
5. R.O. plant water after treatment of ETP effluent

- Use of Storm Water in Green Belt & Firewater network: Rain water is harvested in the refinery and collected in storm water pond. This storm water is used for the irrigation of Green belt and make-up to fire water network

- Hydrogen peroxide Treatment of Process Effluent: Traditionally Ferrous Sulphate Treatment was used for sulfide treatment of Process Effluent. However, this resulted in generation of chemical sludge, which was difficult to dispose. Panipat Refinery introduced hydrogen per oxide treatment of sulfides, which has eliminated chemical sludge generation.

- Bio-remediation of oily sludge: Oil content of Oily sludge is degraded with the oilyvorous bacteria developed by IOCL R&D center and The Energy Research Institute. This process of bio-remediation is used in the refinery to treat the oily sludge generated from tank cleaning and waste water treatment.