



Ref:

Ref: NRL/ENV/PCBA/24-25/08

Date:

Date: 28 September 2024

To,
The Member Secretary,
Pollution Control Board, Assam,
Bamunimaidam,
Guwahati-781021

Sub: Submission of Environmental statement in Form- V for the year 2023-24

Dear Sir,

We are submitting herewith the duly filled in "Environmental Statement" in Form-V for the year 2023-24 for your kind perusal.

Hope, the same shall meet the requirement.

Thanking you.

Yours' faithfully,

(Alok Nayan Nath)

DGM (TS-ENV)

Numaligarh Refinery Limited

Cc: RO, PCBA, Golaghat

[FORM – V]

(See rule 14)

Environmental Statement of NUMALIGARH REFINERY LIMITED for the FY– 2023-2024

PART – A

- (i) Name and address of the owner/occupier:
of the industry operation or process. Numaligarh Refinery Limited
P.O. Numaligarh Refinery Project
Golaghat -785699, Assam
- Co-ordination Office: Tolstoy House, 6th Floor
15-17 Tolstoy Marg
New Delhi-110001
- Registered Office : 122A , G.S.Road
Christianbasti
Guwahati-781005
- (ii) Industry category Primary ----(STC code) : Primary
Secondary----- (SIC Code)
- (iii) Production capacity (Crude T'put) : 3.0 MMTPA
- (iv) Year of establishment : 22nd April ,1993
- (v) Date of the last environmental statement submitted: 29th Sept,2023

PART – B

Water and River Material Consumption

- (1) Water consumption m3/d:
- | | | |
|----------|---|------|
| Process | : | 2588 |
| Cooling | : | 4768 |
| Domestic | : | 3886 |

Name of Raw material: Crude Oil

Process water consumption in m3 per MT of raw material ***:

2022-2023	2023-2024
0.349	0.693

*****As all the products are obtained from the same raw material i.e Crude Oil, Process Water Consumption shown above has been indicated as M3 per MT of crude processed.**

- ii) Raw Material Consumption: Raw material: Crude Oil
- | | | |
|-------------------------------|-----------|--------------------------------------|
| | 2022-2023 | 2023-2024 |
| T'put during the year (in MT) | 3091364 | 2509675 (Design Capacity: 3.0 MMTPA) |

PART - C

Pollution discharged to environment/unit of output (Parameter as specified in the consent issued)

a) Treated Effluent Water: 2023-2024

Pollutants	CPCB Standard (mg/l)	Concen. of pollutants in discharges(av.) (mg/l)	Quantity of pollutants discharged/loss (kg/yr, exc. pH)	Qty of pollutants in kg/1000 MT of Crude		Percentage of variation from STD. with reasons
				Actual	Standard	
pH	6-8.5	7.48				All parameters are within prescribed limit/stds.
OIL & GREASE	5.0	1.86	2152.47	0.88	2.00	
BOD3	15.0	7.66	8877.26	3.64	6.00	
COD	125.0	43.04	49853.41	20.43	50.00	
TSS	20.0	10.55	12216.01	5.01	8.00	
Phenol	0.35	0.09	108.11	0.04	0.14	
Sulphides	0.5	<0.1	0.00	0.00	0.20	
CN	0.2	<0.02	0.00	0.00	0.08	
Ammonia as N	15.0	10.85	12567.36	5.15	6.0	
Cr (Hexavalent)	0.1	0.00000	0.00	0.0000	0.04	
Cr (Total)	2.0	0.00175	2.03	0.0008	0.8	
Pb	0.1	0.00000	0.0000	0.0000	0.04	
Zn	5.0	0.02233	25.8683	0.0106	2.0	
Ni	1.0	0.00217	2.5096	0.0010	0.4	
Cu	1.0	0.00192	2.2200	0.0009	0.4	
Benzene	0.1	<0.1	0.00	0.00	0.04	
Benzo (a)- Pyrene	0.2	<0.2	0.00	0.00	0.08	
Hg	0.01	<0.01	0.00	0.00	0.004	
V	0.2	<0.2	0.00	0.00	0.8	
TKN	40.0	18.09	20958.1424	8.5891	16.0	
P	3.0	1.35	1562.7151	0.6404	1.2	

Note: Quantity of pollutants in kg/1000MT of crude has been calculated considering cumulative Crude processed figures for Q-II,III and IV. Q-I has not been considered due to RTA-2023 and extended S/D till June'23.

(b) AIR

Average Sulphur Dioxide emission from the refinery during – 2023-24:

SO2 Emission, Kg/hr	During April, 2023 to Mar,2024
As per NOC of PCB, Assam max. allowable limit is 256 kg/hr as SO2	78.8 kg/hr

Note : The decrease has been observed this year because of RTA-2023 in April'23 and prolonged shutdown of process units till June 23

2023-24						
AMBIENT AIR QUALITY MONITORING						
STATION	PARAMETER	STD	Unit	OBSERVATIONS		
		NAAQS-2009		MAX	MIN	AVG.
REFINERY (WATCH-TOWER NO. 6)	SO2	80 (24 hr avg.)	µg/m3	18.0	4.26	9.2
	NO2	80 (24 hr avg.)	µg/m3	27.7	8.55	15.6
	O3	100(8 hr avg.)	µg/m3	35.9	0.00	8.7
	CO	2(8 hr.avg.)	mg/m3	1.1	0.00	0.7
	NH3	400(24 hr.avg.)	µg/m3	38.5	0.00	19.9
	PM 10	100(24 hr.avg.)	µg/m3	74.8	21.04	55.0
	PM 2.5	60(24 hr.avg.)	µg/m3	59.4	8.94	34.0
	Benzene	5.0(Annual)	µg/m3	3.2	0.00	0.2
	BaP	1.0(Annual)	ng/m3	0.00	0.00	0.00
	Pb	1.0(24 hr.avg.)	µg/m3	0.4	0.00	0.0
	As	6.0(Annual)	ng/m3	0.00	0.00	0.00
	Ni	20(Annual)	ng/m3	3.8	0.00	0.2
ECO-PARK IN NRL TOWNSHIP	SO2	80 (24 hr avg.)	µg/m3	14.8	5.63	10.8
	NO2	80 (24 hr avg.)	µg/m3	19.6	9.65	14.8
	O3	100(8 hr avg.)	µg/m3	28.6	0.00	13.1
	CO	2(8 hr.avg.)	mg/m3	1.1	0.53	0.7
	NH3	400(24 hr.avg.)	µg/m3	39.0	0.00	16.6
	PM 10	100(24 hr.avg.)	µg/m3	73.1	31.47	51.7
	PM 2.5	60(24 hr.avg.)	µg/m3	56.2	14.80	31.1
	Benzene	5.0(Annual)	µg/m3	3.1	0.00	0.4

	BaP	1.0(Annual)	ng/m3	0.00	0.00	0.00
	Pb	1.0(24 hr.avg.)	µg/m3	0.4	0.00	0.1
	As	6.0(.0Annual)	ng/m3	0.0	0.00	0.0
	Ni	20(Annual)	ng/m3	2.7	0.00	0.4
RAW WATER INTAKE	SO2	80 (24 hr avg.)	µg/m3	16.7	6.40	9.5
	NO2	80 (24 hr avg.)	µg/m3	24.3	7.00	14.9
	O3	100(8 hr avg.)	µg/m3	30.8	0.00	9.2
	CO	2(8 hr.avg.)	mg/m3	1.1	0.53	0.7
	NH3	400(24 hr.avg.)	µg/m3	39.9	0.00	17.0
	PM 10	100(24 hr.avg.)	µg/m3	72.6	32.90	51.3
	PM 2.5	60(24 hr.avg.)	µg/m3	58.0	14.00	31.3
	Benzene	5.0(Annual)	µg/m3	1.9	0.00	0.2
	BaP	1.0(Annual)	ng/m3	0.00	0.00	0.00
	Pb	1.0(24 hr.avg.)	µg/m3	0.4	0.00	0.0
	As	6.0(Annual)	ng/m3	0.00	0.00	0.00
	Ni	20(Annual)	ng/m3	3.6	0.00	0.4
KAZIRANGA WILDLIFE SANCTUARY AT AGARTOLI	SO2	80 (24 hr avg.)	µg/m3	18.0	5.30	9.0
	NO2	80 (24 hr avg.)	µg/m3	27.7	9.26	14.2
	O3	100(8 hr avg.)	µg/m3	27.2	0.00	8.7
	CO	2(8 hr.avg.)	mg/m3	1.1	0.00	0.6
	NH3	400(24 hr.avg.)	µg/m3	38.5	0.00	15.5
	PM 10	100(24 hr.avg.)	µg/m3	66.4	32.47	47.3

	PM 2.5	60(24 hr.avg.)	µg/m3	58.4	12.40	28.5
	Benzene	5.0(Annual)	µg/m3	2.8	0.00	0.3
	BaP	1.0(Annual)	ng/m3	0.00	0.00	0.00
	Pb	1.0(24 hr.avg.)	µg/m3	0.3	0.00	0.0
	As	6.0(Annual)	ng/m3	0.00	0.00	0.00
	Ni	20(Annual)	ng/m3	2.9	0.00	0.3
All the parameters are found to be within limit						

PART – D
Hazardous Wastes

(As specified under Hazardous Waste Management and Handling Rules, 1989 as amended up to date)

Hazardous Wastes(Generated/disposed)	Total Quantity (In MT)	
	During the previous Financial Year (2022-23)	During the current Financial year (2023-2024)
a) From Process		
i) Spent Catalyst (Schedule-1, Category-4.2)	Generation: Nil Disposed: 445.1436 MT (sold to recycler) Stock as on 31.03.23: 2.52MT	Generation: 189.94 MT Disposed: 189.24 MT (sold to recycler) Stock as on 31.03.23: 3.22 MT
ii) Spent Adsorbents	Generation: Nil	Generation: Nil
iii) Tank Bottom (oily Sludge/waste) (Schedule -1, Category -4.1)	Generation: 876 MT Disposed: 500 MT (via bioremediation) Stock as on 31.03.23: 2000 MT, kept in sealed drum for disposal	Generation: 34.540 MT Disposed: 149.155 MT (to authorized recycler) Stock as on 31.03.24: 1885.385 MT, kept in sealed drum for disposal

iv) Slop Oil from Process Units (Schedule-1, Category-4.3)	Generated: 24592 MT Disposed: 5993 MT (sold to recycler) Processed in CDU/VDU: 36593 MT Stock as on 31.03.23: 61771 MT	Generated: 46572 MT Processed in CDU/VDU: 31000 MT Stock as on 31.03.24: 77343 MT
v) Spent lube oil (Schedule-1, Category-5.1)	Generation: 12.998 MT Stock as on 31.03.23: 23.141 MT	Generation: 3.407 MT Disposal = 20.150 MT(to authorized recyclers) Stock as on 31.03.24: 6.398 MT
vi) Schedule-I, Category-33.1: Empty barrels/containers contaminated with hazardous chemicals/wastes	Generation: 3834 Nos Sold:5400 Nos Stock as on 31.03.23: 3396 Nos	Generation: 5018 Nos = 49.30 MT Sold: 1681 Nos= 27.30 MT Internal Reuse = 104 Nos= 1.15 MT Stock as on 31.03.24: 4404 Nos= 25.57 MT
b) From Pollution Control Facilities		
i) Chemical & Oily Sludge (Schedule -1, Category -35.3)	Generated:32.64 MT (disposed off in the SLF)	Generated:6.34 MT (disposed off in the SLF)
ii) Slop Oil from ETP operations (Schedule I, Category 35.4)	Generation: 10300 MT Disposed: 1800 MT (sold to recyclers) Stock as on 31.03.2023 : 8500 MT	Generation: 19915 MT Disposed: 797 MT (sold to recycler) Internal Reuse: 20174 MT Stock as on 31.03.2024 : 7444 MT
iii) Exhaust air or gas cleaning residue (CCU dust) (Schedule I, Category 35.1)	Generation: 652.14 MT Stock as on 31.03.23: 652.14 MT	Generation: 1099.94 MT Stock as on 31.03.24: 1752.08 MT

Part – E

Solid Wastes

Solid Wastes generated /disposed	Total Quantity (in m3)	
	During the previous financial Year (2022-23)	During the current financial year (2023-24)
(a) From Process		
Generation of Incinerable substances -	4365 m3	4370 m3= 920 MT

(b) From pollution control facilities		
Generation at ETP	299.86 MT	Nil
Bio sludge -		
(c)		
(1) Quantity recycled or reutilized within the unit	Nil	Nil
(2) Sold		
(3) Disposal -	Nil	Nil
Incinerable substances -	Entire quantity disposed through incineration	Entire quantity disposed through incineration
Bio sludge -	Entire Quantity disposed off into SLF	Entire Quantity disposed off into SLF

Part – F

Please specify the characteristics (in terms of concentration and quantum) of hazardous as well as solid waste and indicate disposal practice adopted for both these categories of wastes.

A typical laboratory analysis report of the Chemical & Oily Sludge is given hereunder:



NUMALIGARH REFINERY LIMITED
(Quality Control Department)

Analysis of Chemical and Oily sludge sample

Date	SAMPLE SOURCE	PARAMETERS	RESULTS %,wt
23-12-2023 11:30 hrs	ETP (Chemical & Oily sludge)	Moisture Content	85.71
		Oil Content	3.80
		Organic & Volatile Matter	8.89
		Iron	0.10
		Sodium	0.02
		Sulphide	0.22
		Phenol	0.002
		SiO ₂	0.054
		Chloride	0.75
		Calcium	0.04
		Magnesium	0.01
		Manganese	0.002
		Nickel	0.0012
		Sulphate	0.400
		Zinc	0.003
		Lead	0.000
		Copper	0.0002
		Cobalt	0.0001

Analysed By: Mr. Prabhash Kumar Thakur

Barhai

Certified by: Dr. Bedobrat Barhai
Officer (Quality Control)
Numaligarh Refinery Limited
Golaghat, Assam
Pin: 785699

बेदब्रत बर्है / BEDOBRAT BARHAI
चरित अफिशर (गुणवत्ता नियंत्रण) / Sr. Officer (Quality Control)
नुमालिगरह रिफाइनरी लिमिटेड / Numaligarh Refinery Limited
गोलाघाट, असम - 785 699 / Golaghat, Assam - 785 699

Disposal practice adopted for both categories of wastes:

A proper solid waste management procedure is in place at Numaligarh Refinery to deal with the storage/disposal of solid wastes (hazardous /non-hazardous) generated due to refinery operations. As a part of the operation of the refinery, some amount of solid wastes are generated - to manage and deal with the same, an environment-friendly & proper solid waste management system has been prepared and as per the laid down procedure hazardous /non-hazardous solid waste is handled. Considering the activities

related to waste management, NRL Management has delineated a solid waste management plan with the following objectives:

1. To protect human health and the natural environment from the hazards posed by waste disposal.
2. To conserve energy and natural resources through waste recycling and recovery.
3. To reduce /eliminate, as far as possible, the generation of solid wastes including hazardous wastes.
4. To ensure proper management of solid wastes which protect human health and the environment.

In-built measures had been adopted to minimize, control pollution and the generation of waste in all the units with proper collection and disposal systems.

The disposal practice adopted for hazardous as well as solid waste has been indicated as given below:

Hazardous waste :

- **ETP Chemical and Oily Sludge:**

Adequate segregation, collection, and treatment facilities for wastewater for centralized treatment have been provided to meet the stringent standards laid down in the latest MoEFCC Notification. An environmentally compatible management system for disposal of the ETP hazardous wastes i.e. Chemical & Oily sludge through a Secured Landfill has been developed inside the refinery premises. Types of Hazardous solid waste like – Chemical & Oily sludge which is generated at different sections of the Effluent Treatment Plant (ETP) are collected in a sludge thickener through a sludge collection system. Floating oil with water from the thickener is recycled back to the Inlet Receiving Sump (IRS) of ETP for further processing and oil recovery. The thickened sludge from the bottom of the thickener is taken to the centrifuge feed sump for feeding to the specifically designed Chemical & Oily centrifuge for recovering the absorbed oil from it. By using the highly efficient centrifuge, almost total oil is recovered from the sludge and is recycled back to the slop oil system for reprocessing. The oil-free cake from the centrifuge was disposed of in the Secured Landfill (SLF). A Secured Landfill with a capacity of 6000m³ has been constructed inside the Refinery Premises.

- **Tank Bottom Oily Sludge**

Tank bottom sludge generally is sold to CPCB-recognized recyclers. The same is also disposed of through Bio-remediation more scientifically and efficiently in the Refinery premises itself. To cater to the requirement, two number Bioremediation facilities(1200 m³ each) are available for bioremediation of Crude Tank cleaning sludge.

- **Spent Catalyst**

Spent catalysts are generally generated after a gap of 3/4 years when the catalyst is required to be replaced in the various units of the Refinery. After generation, the spent catalyst is kept in sealed drums at the demarcated place for onward selling to CPCB-approved recyclers with due intimation to PCBA and following the stipulated guidelines/procedures. Spent catalysts are sold to CPCB-recognized recyclers by following proper guidelines with intimation to SPCB.

- **Slop oil**

Slop oil is generated from the process units in the refinery and is stored in the Slop oil tanks under the Oil Movement & Storage Unit. Slop oil is also generated in ETP during the wastewater treatment processes and the same is recovered and transferred to OMS for further treatment and processing. The slop oil generated is treated in a 3-phase decanter system for efficient slop management of the refinery and is reprocessed in the CDU. Slop oil is also sold to CPCB-authorized recyclers.

- **Spent Lube oil**

Spent lube oil is usually generated in the refinery during the maintenance activities of the various equipments and machinery operated in the process plants. The spent lube oil generated is kept in drums at demarcated locations and is sold off to CPCB-approved recyclers as per guidelines.

- **Empty Contaminated Barrels**

A lot of barrels/containers/drums are used in the refinery for the intermittent storage of hazardous waste/ chemicals/ oil and lubricants etc. The empty barrels that are generated post respective usages are kept in demarcated locations and are disposed of by selling the same to CPCB-authorized recyclers.

Non –hazardous solid waste

Non –hazardous solid waste generated in the Refinery are mainly - incinerable waste, non-incinerable but reusable waste and biodegradable waste, etc. After collecting the wastes from various sources viz. - process area, various units, admin office, and other locations, wastes are segregated and kept in demarcated locations in the Solid waste disposal yard. Non-hazardous solid waste like- paper, hard boards, packing materials/papers, and cartons are incinerated through an incineration process and non-hazardous bio-degradable wastes are disposed of by burying at isolated low-lying areas within the refinery premises itself.

Part –G

Impact of the pollution abatement measures taken on the conservation of natural resources and the cost of production:

NRL has determined the sources of pollution in various activities focusing on pollution load. Company's management is very careful and proactive regarding the environmental impacts of the new initiatives and products. NRL is conducting the Environmental Impact Assessment study of every project to understand the implications of setting up any new project or unit. Significant contribution made by NRL on the specific contribution on innovative clean technology, sustainability, broader user or target groups on the following fields:

- a) Environment-friendly technology adopted for highly polluting industries.
- b) Innovativeness/creativity of clean technology.
- c) Any significant contribution towards the manufacture of environmentally friendly products.
- d) Abatement including reduction reuse, recycling, or any beneficial use of waste generated.
- e) Substantial and steady reduction in the effluents and emissions in the year.
- f) Success in defining environmental pollution needs meeting pollution prevention goals and overall improvements to the quality of air, water, and land.
- g) Reduction of risk to the community living in the vicinity of units handling hazardous chemicals.
- h) Sustainability of the developed environment-friendly technology from financial, social, and ecological aspects.

As the higher fuel consumption directly contributes to the higher emission of greenhouse gases affecting natural ecological processes, energy conservation efforts have received continuous focus at NRL since the conceptualization of the refinery by applying optimum consumption of fuel in furnaces thereby reducing the rate of emission of Green House Gas. It has adopted state of the art energy efficient technology, high-efficiency furnaces with glass air pre-heaters, plate-type exchangers, installation of a captive co-generation power plant using a heat recovery system, maximization of waste heat recovery, installation and operation of power recovery turbine in the hydrocracker and other units, etc.

NRL has adopted very advanced and comprehensive steps towards controlling pollution. From the very onset, the selection process of technologies and equipment was done with special care for environmental protection.

Additionally, all the furnaces are provided with ultra-low NOx burners. Low-noise rotary equipment were considered during the time of equipment selection.

Minimum Generation of waste: In-built measures have been adopted to minimize and control pollution and the generation of waste in all the units with proper collection and disposal systems.

Adequate segregation and centralized treatment facilities: Adequate segregation, collection, and treatment facilities for wastewater for centralized treatment have been provided to meet the stringent standards laid down in the MoEFCC notification, 2008.

Details regarding the some of the pollution abatement measures of NRL are as follows:

1. Effluent Treatment Plant with the latest technology

A centralized modern Effluent Treatment Plant having tertiary treatment facilities has been installed. Also, the ETP includes a three-stage oil recovery system from the wastewater and a high-efficiency centrifuge for recovering oil from the oily sludge. To avoid hazardous solid waste generation, a more environmentally friendly hydrogen peroxide treatment process has been introduced. Discharge of Treated Effluent from ETP via dedicated pipeline has been discontinued since October 2000 and discharge of effluents from Sewage Treatment Plant has been discontinued since April 2007. The treated effluent from the Township is diverted to our ETP inside the Refinery by implementing suitable modifications in the disposal line in ETP, where the treated water from the township STP is received at the aeration tank. The outlet at Numaligarh Jetty in river Dhansiri has been blinded and the discharge from township STP also has been routed to ETP through the same line. About 50-60% of treated effluent is being reused/recycled in miscellaneous refinery activities and as Firewater makeup and the rest quantity is system/operational losses in ETP due to various constraints. As a part of ETP modernization VOC recovery system has been implemented.

2. Green Belt Development

An ambitious plan of green belt development has been adopted around the refinery to serve as a barrier for air pollutants and noise. A 100m wide green belt around the refinery and 25 m wide around the marketing terminal covering 56 Ha of land has been developed and thereby rendering a perfectly natural barrier to the industrial noise, minor air pollutants from reaching the immediate surroundings, both human population, rich flora & fauna and help in mitigating the effects of fugitive emission in all around Refinery. There are green covers of tea gardens (tea bushes and shed trees) in the northern and southern boundary of the refinery with approx. 260 hectares, contiguous to the refinery Green Belt. The township situated about 5 KM from the refinery is spread over 250 acres area. Although the township is full of natural green vegetation, large nos. of trees have been planted on both sides of roads and other parts of the township. Initially plantation of around 1,25,000 nos of saplings of various species was carried in the Green Belt around Refinery and

20,000 nos in the Green Belt around NRMT. Massive plantations are being carried out every year in the Green Belt to increase the density of trees. Around 55900 saplings have been planted in the Green Belt area during 2000-2018. Plantation activities inside the Refinery as well as outside the refinery have been carried out in a phased manner considering weather conditions. The meticulously planned and developed green belt all around the refinery has now grown into rich foliage, rendering a perfectly natural barrier to the industrial noise and minor air pollutants from reaching the immediate surroundings, both the human population and the rich flora and fauna. NRL is aggressively pursuing tree plantation in the refinery area with a plantation of around 7000 saplings during 2018-2021. Plantation drives in nearby areas of the refinery are taken from time to time under various schemes & programmes.

NRL has taken up two major flagship initiatives for plantation under Afforestation Drive in degraded areas. An MoU was signed on 14.09.2020 between NRL and Golaghat Social Forestry Division, Government of Assam, for the plantation of 1 lakh tree saplings (equivalent to 2200 Ton of CO₂ absorption per annum), towards compensatory afforestation of 40 Hectares of degraded land in Nak-Kati Chapori under Khumtai Revenue Circle of Golaghat.

In a significant development for plantation of approx. 68000 tree saplings (equivalent to 1496 Ton of CO₂ absorption per annum), an MoU was signed on 23rd August 2021 between NRL and Nagaon Forest Division, Govt. of Assam for compensatory afforestation of 35 Hectare land in Kandoli PRF under Nagaon Forest Division with a total budget of ₹1.97 Crore.

NRL has also further pursued the Forest Department, Govt. Assam for providing 28 Ha. land in Abhoypur Village, Dibrugarh District for compensatory afforestation. Accordingly, a proposal along with an estimate of about 2.2 crores has been submitted by the Additional Principal Chief Conservator of Forest & Chief Executive Officer(CAMPA), Assam for a plantation target of 3,50,000 saplings (equivalent to approx.7700 Tons of CO₂ absorption per annum).

Keeping the environment as a prime concern, NRL has envisaged an ambitious experimental project for the first time in the country. This unique project called “Butterfly Eco System” located in the Refinery Township is an effort to give a natural habitat for butterflies to come, stay, and breed in their natural way. Also, a unique herbal garden of rare medicinal plants called “Smritibon” has been developed in the township.

In addition, the plantation of various saplings has also been carried out on a wide scale all along the roadsides in the Township & the Butterfly Valley. More than 84% of green cover is maintained in the Township.

3. Unique Ground Flare System

To avoid any adverse impact of the flare on wild animals in the Kaziranga National Park, a non-illuminating ground flare has been incorporated which is the first of its kind in the country.

4. Sulfur Recovery Plant

Assam crude is sweet crude (only 0.26 % Sulfur content). Despite processing low-sulfur Assam crude, a Sulfur Recovery Unit (SRU) has been installed to remove sulfur from sour water and sour gas generated during the refining process. Subsequently, its capacity has been enhanced from 14.6 Tonnes Per Day to 19.3 Tonnes Per Day in the year 2010 commensurate with the Diesel Quality Upgradation Project.

Implementation of a new train of Sulphur Recovery Unit (SRU) has been taken up for parallel execution to meet future environmental requirements along with the implementation of Tail Gas Treating Unit (TGTU). As a remarkable achievement, NRL successfully commissioned the Tail Gas Treating Unit (TGTU) in Feb'24, and sulphur recovery efficiency increased from the existing 96% to 99 %.

5. High Stack Height & Strict Emissions Monitoring

To reduce the ground-level concentration of pollutants, the height of stacks at different plants in the refinery is kept at 60 meters. Further, the height of the stack at the Coke Calcination Unit is kept at 77 meters. Facilities for continuous monitoring of SO_x, NO_x, PM, and CO have been provided for all the furnace stacks and low NO_x burners have been used in all the furnaces. Real-time online emission data have been transmitted to the CPCB/SPCB server continuously with a remote alert facility. SO₂ emission from the refinery is 78.8 kg/hr for FY-23-24 as against the allowable limit of 256 kg/hr (The decrease has been observed this year because of RTA-2023 in April'23 and prolonged shutdown of process units till June 23).

6. Use of low sulfur fuel for the Refinery furnace

Only sweet fuel gas, after removing sulfur in the Amine Treatment Unit, is used in the refinery furnaces.

7. Waste Management System

NRL has taken up a lot of advanced & innovative initiatives in the management of Waste generated in the refinery.

NRL has also successfully registered in the National Hazardous Waste Tracking System (NHWTS) during an online portal developed by CPCB for tracking the generation, transformation, storage, recycling, utilization, and disposal of Hazardous Waste in the country. Management of various types of waste generated in the refinery is described below:

- **Chemical and Oily sludge**

Chemical and Oily sludge generated at different sections of Effluent Treatment plant are centrifuged in the highly efficient Centrifuge to further remove the oil content. After centrifuge, the oil-free cake is kept in sealed drums which are then disposed of in the Secured Landfill.

- **Tank Bottom Oily Sludge**

Tank bottom sludge generally is sold to CPCB recognized recyclers. The same is also disposed of through Bio-remediation more scientifically and efficiently in the Refinery premises itself. Cleaning of Tank bottom oily sludge has been done by adopting modern tank cleaning methods using a Tricanter centrifuge system for maximum recovery of hydrocarbon and reduced sludge generation. 500 MT of accumulated Oily sludge generated in the refinery has been sold to CPCB approved recycler out of which disposal has been completed for 149 MT.

- **Spent Catalyst**

Spent catalysts are generally generated after a gap of 3/4 years and are sold to CPCB-recognized recyclers by following proper guidelines with intimation to SPCB. About 189 MT spent catalyst generated during Refinery Turn Around (RTA-2023) was sold to CPCB-approved recyclers.

- **Slop oil**

The slop oil generated is treated in a three-phase decanter system for efficient slop management of the refinery and is reprocessed in the CDU. About 797 MT of slop oil from ETP has been sold to CPCB-approved recyclers.

- **Spent Lube oil**

The spent lube oil generated is sold off to CPCB-approved recyclers as per guidelines. 20 MT of spent lube oil has also been sold to CPCB-approved recyclers.

- **Empty Contaminated Barrels**

The empty barrels that are generated post respective usages are disposed of by selling the same to CPCB-authorized recyclers.

- **Plastics waste**

The plastic packaging waste like stretch films generated in the Wax slabbing unit is collected back by the respective vendors. NRL has received the Registration certificates for Brand Owners and Importer this year as per the Extended Producers Responsibility (EPR) regime under implementation in Plastic Waste Management Rules, 2016.

- **E-waste**

The defective components of repaired machines are taken back by the contractors after replacement. Laptops have a buy-back company policy. Desktops are mostly reused in low-priority areas and donated through CSR. The balance minimum nos. are handed over to the

warehouse for disposal through auction from time to time. 37 MT of E-Waste generated from the Electrical, Instrumentation, and Quality Control Laboratory departments of NRL were successfully disposed of to recyclers during this year.

- **Used Batteries**

Used batteries are disposed of through the manufacturers/ vendors as buy-back arrangements. 17.57 MT used batteries were sent as buyback to the dealers.

8. Implementation of Hydrogen Peroxide Treatment

In pursuance of the latest development, the H₂O₂ treatment process has been introduced for the chemical treatment of wastewater in the ETP by replacing the conventional FeCl₃ process. The introduction of this technique has reduced the solid waste generation drastically.

9. Installation of oil traps in the stormwater drains

Several numbers of oil traps have been installed and hay filters, and oil absorbent booms are placed in the refinery stormwater system as a preventive measure to eliminate any possibility of oil being carried over to the outside environment. The storm water recycle project is being implemented for reuse.

10. Estimation of Carbon Footprint and Green House Gas Emission

NRL is focusing on energy efficiency, building carbon sinks to minimize Green House Gas (GHG) emissions. NRL continues to monitor its GHG inventory and get it validated through an accredited agency. The company engaged TUV India Private Limited to conduct the independent assurance of the Refinery's GHG emission, which includes a "limited level of assurance" of NRL direct and other indirect (Scope 1 and 3, there are no Scope 2 emissions presently) GHG emission. This assurance engagement has been conducted against the methodology & standards of API compendium 2021, ISO 14064, GHG protocol ISAE 3000 (revised), and ISAE 3410 (GHGs) for the verification process under the operational control approach. GHG emission stands at 0.699 and 0.840 million tons CO₂ equivalent during FY 2023-24 & 2022-23 respectively against crude processed of 2.5097 MMTPA and 3.091 MMTPA respectively.

11. CDM Projects

NRL has installed a 12.0 MW Steam Turbine Generator (STG) to utilize and recover waste (thermal/pressure) energy of HP steam. This project has been registered as a CDM Project and NRL has earned Carbon Emission Reductions (CERs) from UNFCCC.

12. Fuel switch over

NRL has entered a JV with Oil India Ltd (OIL) and Assam Gas Company Ltd (AGCL) to form the Duliajan Numaligarh Pipeline (DNPL) who laid a 192 KM pipeline from Duliajan to Numaligarh to supply Natural Gas (NG) which is currently used at Captive Power Plant (CPP) and Hydrogen Unit of NRL instead of Naphtha. This has resulted in the reduction of carbon emissions.

PART – H

Additional measures/investment proposal for environmental protection including abatement of pollution, and prevention of pollution:

1. Secured Land Fill

As per CPCB recommendations with the latest technic/scientific design, a Secured Landfill with capacity of around 6000 m³ is in operation in the Refinery premises to cater the needs for disposal of Chemical & Oil Sludge.

2. Bioremediation facility

Two nos. of Bioremediation facilities (1200 m³) are available in the refinery for bioremediation of tank bottom oily sludge.

3. Decanter System

A three-phase decanter system has been commissioned for efficient slop management of the Refinery. About 50-70 KL of slop can be processed per day and the resultant processed slop can be directly transferred to the CDU unit for re-processing along with crude.

4. Installation of double mechanical seals in IFRT (Internal Floating Roof Tanks) and EFRT (External Floating Roof Tanks) in line with MoEFCC notification, 2008, relating to the Oil Refinery Industry, setting of double mechanical seals in all the IFRT and EFRT tanks have been completed.

5. Transmission of online real-time data

Transmission of online real-time data with remote alert facility for SO₂, NO_x, CO, PM, and Ambient Air quality to CPCB and SPCB Server has been implemented. As per directions of CPCB, online transmission of Treated effluent data for four parameters i.e. pH, TSS, BOD, COD, and flow have been implemented.

6. Installation of additional CAAQMS

As per the recommendation of MoEFCC and CPCB – the installation of another Continuous Ambient Air Quality Monitoring Station (CAAQMS) in the downwind direction has been completed and commissioned. Another CAAQMS is being planned to be installed as a part of NREP activities.

7. Dust mitigation activities

3 nos. of Mist Cannons are being utilized at project/construction sites as per requirement for control of dust pollution. Water sprinkling using tankers along major haul roads of the refinery is also being carried out. A wheel Washing system has been installed for vehicles exiting the Refinery Project gate for the control of dust pollution outside the refinery premises along with regular water sprinkling on the roads by tankers.

8. Flare Gas Recovery System

Numaligarh Refinery was originally designed with a twin flare system i.e., the ground flare and the elevated flare to avoid any adverse impact of the illumination of flare on animals and migratory birds in the surrounding wildlife sanctuaries and protected forest including Kaziranga National Park. In normal operation, the ground flare is in line and only the pilot burner is lit up in the elevated flare. The elevated flare caters to the load during plant emergencies when the flare load is very high or during maintenance of the ground flare system.

As a measure for the further protection of the environment & conservation of energy, the Flare Gas Recovery System has been implemented to recover and reuse the excess gas going to the flare.

The flare Gas Recovery System (FGRS) supplied by M/s Garo SPA, Italy was successfully commissioned in the year 2018-19. Implementation of the Flare Gas Recovery System has not only reduced specific energy consumption of the refinery but has also reduced Greenhouse gas emissions.

9. Despatch of Ethanol Blended Motor Spirit

NRL has commenced despatch of Ethanol Blended Motor Spirit (EBMS) from its Marketing Terminal in Numaligarh for supply to Retail Outlets located in North-East India. The first tank truck loaded with EBMS was despatched on 03-03-2022 from Numaligarh Refinery Marketing

Terminal to be sold through BPCL Retail Outlet. This augurs well with the Govt of India's target to achieve 20% blending of Ethanol with MS (Petrol) by 2025.

India imports 85% of its crude oil requirement. Ethanol, produced domestically, blending in Motor Spirit (Petrol) assumes significance at a time when the Govt. of India is focused on reducing import dependence, thereby saving on foreign exchange while promoting green energy. Also, ethanol is a less polluting fuel and offers equivalent efficiency at a lower cost as compared to MS (Petrol).

NRL has recently commissioned 2 above-ground tanks of capacity 860 KL each, through its subsidiary ABRPL, along with modification of existing truck loading gantry facilities to enable online blending of Ethanol in required proportion before it is dispatched to its customers. NRL's joint venture company, M/s Assam Bio-Refinery Pvt. Ltd. which is executing the first 2G biorefinery with bamboo mass as feedstock and bioethanol as one of the products is all set to be commissioned in the latter part of this year, which will substantially cater to the ethanol requirement in the Northeast region and beyond.

10. Maximum product evacuation through pipeline

About 80% of the product evacuation takes place via NSPL (Numaligarh Siliguri Pipeline) thereby contributing as an initiative towards reducing vehicular traffic for product despatch.

PART – I

Any other particulars for improving the quality of the environment:

As a part of continuous efforts towards reduction of emissions, Numaligarh Refinery produces ultra –low sulphur High Speed Diesel and motor spirit having less than 0.001% (10ppm) sulphur conforming to the Euro-VI Specifications. This contributes to reducing pollution from diesel and petrol vehicles due to the reduction in emission of Sulphur dioxide into the atmosphere.

Numaligarh Refinery Limited (NRL) has upgraded its refinery for production of BS-VI HSD to meet product quality requirements as per the Auto Fuel Policy of the Government of India by the implementation of the Diesel Hydro Treater Project (DHDT), which was commissioned in January 2018. NRL has also increased the capacity of its MS plant by 50% in 2019 and the entire quantity of MS produced meets BS VI standards.

As an advanced step towards environment protection, NRL has installed four mounded Bullets which are more environmentally friendly and safe for the storage of LPG replacing the existing LPG spheres.

Energy conservation measures:

NRL prioritizes maintaining energy conservation and enhancing its energy efficiency. Refinery closely monitors the key energy performance indicators viz Specific Energy Consumption and Energy Intensity Index (EII) out of several operational parameters. The Specific Energy Consumption (SEC) was 61.57 MBN and Energy Intensity Index (EII) was 81.36% against a target of 61.7 and 82% respectively for FY 2023-24.

Numaligarh Refinery has a portfolio of 1.05 MW of solar photovoltaic capacity, which is 0.4% of total captive power generation. The total generation from solar power is 820.9 MWh in 2023-24 which translates to reducing 6.3 lac lbs CO₂e. NRL continues to pursue the opportunity for further electricity production through solar resources in extended areas.

Details of energy conservation schemes implemented in FY-23-24 are given below:

- A condensate recovery system through steam traps routed to CPP was commissioned in the Sulphur Recovery unit.
- Reduction in NG as fuel and maximizing utilization of PSA off-gas after cleaning of APH system in hydrogen generation unit during planned RTA'23.
- Online digital twin model implemented in preheat circuit of CDU/VDU. The output of the simulation twin model enabled optimal use of energy in the heater.
- Ensuring Steam trap performance rate at >98% in working condition.
- Tail Gas treating unit commissioned in Feb'24 to improve the Sulphur recovery efficiency from 96.0% to 99% with additional production of sulphur of around 4% and reduce mass loss in terms of sulphur. Moreover, TGTU resulted in a significant reduction in SO₂ emission from 6000 ppm to 100-300 ppm.

Other Highlights:

- Perform Achieve Trade (PAT) cycle-VI verification by an Accredited energy auditor for the assessment year 2022-23 resulting in the issuance of 1863 nos. of Energy Saving certificates (ESCerts). NRL traded ESCerts in the PXIL trading platform by selling 771 ESCerts at ₹1840 per ESCerts during FY 2023-24 against 4289 ESCerts earned in PAT cycle-II.
- NRL procured 20596 Renewable Energy Certificate (REC) in PXIL trading platform to comply to Renewable Purchase Obligation (RPO) for period FY 2022-23 and 2023-24 under CPP owner category.

The details relating to energy conservation measures implemented in FY-22-23 and FY-21-22 are as below:

Sl. No.	ENCON measures - 2022-23	SRFT saving	Sl. No.	Energy efficiency Improvement measures taken up during RTA'23
1	Condensate Recovery System commissioned in Hydrocracker Unit	150	1	Breech-lock exchanger cleaning in HCU; Hydro-jetting of all preheat train exchangers of CDUVDU, DCU, MSP, DHT, Wax unit; internal and external tube body cleaning of fin-fan coolers/EEs
2	Heat Integration of CDUVDU exchanger EE-51 A/B with DCU 03-EE-01A saving 0.5mmkcal/h	500	2	Regeneration of CRU catalyst; partial catalyst loading in HCU & SRU
3	Efficient utilization of enrich O2 stream of both N2 plants to improve performance in SRU	720	3	Cleaning of APH of Reformer HGU EE-204 A/B; EE-215; Tube & tube sheet replacement of WHB EE-206
4	HCU Feed Pre-heater steam reduced substantially	900	4	STG main surface condenser cleaning to improve vacuum
5	Steam trap performance rate at >98% in working condition	2200	5	Installation of high precision ultrasonic mass flowmeter for Fuel NG in GTG-1 & GTG-2
			6	Closed Gas sampling points in all process units
			7	DHDT Internal Fuel gas hook-up directly to its furnace for operational ease
			8	Stop steam loss due to frequent steam trap passing with Installation of control valve at condensate pot outlet of reheater-2&3 in SRU-I.
	Total	4470		

S.I.	Encon schemes in 2021-22	SRFT
1	Boiler blowdown recovery system commissioning in Hydrocracker Unit	65
2	Reduction in external fuel NG in Hydrogen generation unit and increasing internal off-gas in reformer by optimising steam carbon ratio at 2.45 instead of earlier 2.5 since later Oct'21	450
3	CDU Preheat temperature in heater increased at 288° C consistently after opportunity shutdown in Dec'21	1920
4	Plate type Diesel Product cooler installed in Hydrocracker Unit	2500
5	Waste Heat Recovery Boiler in Sulphur Recovery Unit for steam generation(@1.5Tph) after installation of NOx reduction furnace	900
6	Steam trap performance rate at 98% in working condition	950
7	Reduction in flue gas loss from Utility Boiler	274
8	Improving performance of condenser of steam turbine	110
9	Optimize Boiler Feed Water System of CCU WHRB Boiler	96
10	Bag filter and duct leakage in WHRB of CCU attended	135
	Total	7400

Energy conservation measures planned beyond FY-22-23:

1. Online Digital Twin Model development for CDU/VDU and integration with column model
2. Online predictive analysis tools with AI & ML to detect loss from steam traps, ultrasonic PSV, IP21 wireless sensors;
3. Condensate recovery scheme in balance units;
4. Replacement with energy efficient motor and pump in process units;

Other schemes adding to continual benefit:

1. Steam traps dynamic analysis and monitoring.

2. Regular monitoring of Hydrocarbon passing of all valves connected with flare system by Acoustic Leak Detector and Fugitive emissions from tanks, line flanges etc, throughout the year under LDAR program.
3. Continuous operation of APC in CDU, DCU, HCU and H2U.
4. Conventional light replacement with Energy efficient light
5. Steady operation of 12 MW STG for Captive Power generation by utilizing and recovering waste energy (thermal and pressure) of HP steam, Maximization of NG use for continual improvement in the energy consumption, Increased Reliability with installation of Prognostic Online monitoring system for Off-Gas and Make-up Gas Compressor of HCU. There has been increase in productivity, safety and reduction of unplanned outages & maintenance cost, Replacement of higher heat duty exchanger EE-01 in HCU, etc.

ENCON schemes implemented during 2020-21:

1. Feed effluent exchangers (Shell & Tube type) have been replaced by Plate Type Heat Exchangers in Sulphur Recovery Block. Equivalent annualized saving is 1600 SRFT.
2. Installation of electrical tracing in Solvent De-oiling Unit and offsite of Wax Plant replacing the steam tracing. Equivalent annualized saving is 615 SRFT.
3. Optimization of excess air in furnaces of Crude Distillation Unit, Vacuum Distillation Unit and Hydrocracker Unit. Equivalent annualized saving is 500 SRFT.
4. Condensate recovery scheme in Delayed Cocker Unit and Captive Power Plant. Equivalent annualized saving is 450 SRFT.
5. Replacement of electrical motors and pumps with energy efficient motors and pumps. 590SRFT
6. Improvement in stream trap performance rate to 99% in working condition. Equivalent annualized saving is 150 SRFT.

ENCON schemes implemented during 2019-20:

1. Burners (216 Nos.) in the reformer of Hydrogen Unit were replaced by FPMR-5 burners to increase reformer outlet temperature and reduce methane slippage. Steam generation has increased by two-fold and equivalent annualized saving is 4000 SRFT (Standard Refinery Fuel Tonne).
2. A new plate and glass enameled carbon steel tube Air-Preheater (APH) installed in CDU/VDU replacing the old cast / glass APH. Equivalent annualized saving is 1060 SRFT.
3. Booster pumps (2 Nos.) in CDU/VDU have been replaced from API 6th edition to API 10th edition. Equivalent annualized saving is 350 SRFT.

4. Capacity of MS Plant has been augmented by 50% with modifications in NHT Pre Heat Train, new convection coil in CRU inter heater and waste heat utilization for generation of superheated steam in CRU. Equivalent annualized saving is 1300 SRFT.

ENCON schemes implemented during 2018-19:

1. CDU Pre-heat improvement by 15 deg C with introduction of new HGO CR loop. Net saving is 2500 MTOE (Metric Tonne Oil Equivalent).
2. FGRS commissioned in Flare area to recover refinery flared gas. Net saving is 1800 MTOE.
3. 1 MW rooftop Solar panel installed within the Refinery premise. Net saving is 220 MTOE.
4. Electric heat tracing in WHFU. Net saving is 500 MTOE.
5. Auto water decantation valve installed in all Crude and slop tanks to reduce oil carryover in ETP.
6. Sun-domes installed in Warehouse and Electrical Lab to reduce artificial lighting.
7. Trial online Antifouling chemical injection programme in preheat train of CDU/VDU has been found to be successful leading to energy conservation.
8. Application of new e-glass fibre insulation in DCU transfers line has resulted in reduction of heat loss.
9. Implementation of APC (Advanced Process Control) in MSP and Wax Unit and continued operation in CDU, DCU, H2U and HCU has helped in reduction in energy consumption.

ENCON schemes implemented during 2017-18:

1. Stoppage of Turbine driven Fuel oil pump and switched to motor. Saving of 3.5TPH MP steam in lieu of 45KW motor. Net saving is 1200 MTOE.
2. Reduction of reboiler steam in MSP-DIH with operational change. Net steam saving leading to saving of 300MTOE.
3. 10 KW rooftop Solar PV panel installed at the NRMT admin Bldg and Control room.
4. Achieved zero steam leak by attending leaky steam traps and i/l valve.
5. Stoppage of steam tracing in SDU feed line and the tank heating steam coils of Solvent de-oiling unit. Stoppage.
6. Trial installation of E-glass fiber insulation in DCU transfers line. Shell outside temp dropped by 15- 20degC.
7. Air Compressor 3rd stopped (400KW) with close monitoring, Isolating the plant air at battery limit.
8. Reuse of Storm water as CT make up at 300m³/h
9. PATII mandatory Energy audit by PCRA and Energy efficiency Improvement study by EIL done during the year. Recommendations taken up for implementation at various phase.
10. Overhauling of STG turbine and improvement in condenser vacuum done during the year lead to a saving of 1500 MTOE
11. GTG exhaust to HRSG SH inlet heat loss plugging done. This lead to saving of 3000 MTOE.

ENCON schemes implemented during 2016-17:

1. Maximizing reformat production with reduced energy by internal modification and increase in Isom plant load by conversion of available redundant equipment as DIH bottom pump. This has resulted in saving of around 1.5TPH LP steam and realization of 38KW of power.
2. Hook up of Hot VGO line with cold VGO line to maximize hot feed in HCU.
3. Incorporating heater bank coil for NG heater 34-HE-121 -01/02 up to 43 degC thereby stopping MP steam in NG heater.
4. Uprating of Gas Turbine by 4-5 MW has helped in single GT operation even with increase load of new units.
5. CDU VDU column internal replacement with structured packing has resulted in improved vacuum, less COT by 5 degC with same distillation yield profile. This has reduced energy consumption significantly
6. Chemical cleaning/foam cleaning of exchangers/columns/CR loops done which resulted in increase in preheat temp
7. Burner alignment checking done for all major furnaces for efficiency improvement
8. Significant saving potential in electrical energy has been identified through system drive audit carried out for all motors and pumps through PCRA (Petroleum Conservation Research Association)

ENCON schemes implemented during 2015-16:

1. CDU/VDU column internal modification for yield/energy optimization.
2. Installation of plate type heat exchanger (air pre-heater) in HGU flue gas duct.
3. Replacement of catalyst in RB-02 of Isomerization Unit.
4. Replacement of old trays with High Capacity Tray in HCU fractionators' kero zone.
5. Emissivity coating for controlled thermal radiative and convective heat transfer from the Furnace surface and tubes of Process units.
6. Up-rating of GTG-1 for augmentation of capacity (4-5MW).
7. Replacement of metallic blades with E-FRP blades in all the air fin fan coolers of the Process Units
8. Installation of Ultrasonic Activator in CDU/VDU in upstream of crude booster pump
9. Use of FO additive program post successful trial run with resulted fuel savings.
10. Modification in DCU by diversion of Slop as Quench instead of SRGO as quench. This has enabled reduction in slop generation.
11. HP steam header pressure reduction from 41kg/cm² to 39.0 kg/cm² resulting in savings of fuel.
12. Energy management system implementation in Electrical metering system. Online energy consumption is now available in desktop in micro level for any critical equipment.
13. Diversion of the Stabilizer off gas ex -CDU to DCU off -gas compressor to recover the LPG component from fuel gas.

Technology Absorption, Adaptation and Innovation measures:

1. Numaligarh Refinery Expansion Project (NREP)

NRL is in the process of augmenting its refining capacity from 3.0 MMTPA to 9.0 MMTPA, by setting up a new refinery train of 6.0 MMTPA in the existing premises.

The project is being executed using a mixed implementation model engaging a combination of PMC, EPC, EPCM, and other supporting consultants. The Hydrogen Generation Unit will be set up in "JOB WORK" mode. Delivery of Process Package, including engineering for all the units are completed and overall progress made as on 31st 2024 is 55.9%. Noteworthy technologies adopted are PFCC units for high yield of Propylene and Ebullated Bed Resid Hydrocracker (RPTU).

Capacity expansion of NRL from 3.0 MMTPA to 9.0 MMTPA will ensure additional availability of petroleum products primarily LPG, MS and HSD in the NE and Eastern region of India and meet the growing energy demand in the region. Additionally, during the year, 38 TMT of Gas Oil was exported to Bangladesh through the India-Bangladesh Friendship Pipeline (IBFPL) from NRL's terminal in Siliguri which was commissioned in March 2023.

2. Bio-Refinery Project

NRL is setting up a 49 TMTPA Bio Refinery project as a joint venture company promoted by NRL with 50% equity and a balance of 50% by Fortum 3. B.V Netherland and Chempolis Oy, Finland for producing ethanol from cellulosic feedstock 'Bamboo'. The process to produce bioethanol from bamboobiomass is based on the Formicobio Technology from M/s Chempolis. Overall progress of the project is 95% as of 21st June 2024.

Bio-Ethanol production from the Bio- Refinery shall be used in blending with Motor Spirit by North-East refineries. Bio Refinery project will help in meeting the 20% Ethanol Blended Petrol (EBP20) programme of GOI's National Biofuel Policy by 2023-24 which will in turn help to strengthen the country's energy security, enable local enterprises and farmers to participate in the energy economy and reduce vehicular emissions.

3. Wax Pastillation Unit

NRL has commissioned a new Wax Pastillation Unit (WPU) during March 2023 with a production capacity of 144TPD. M/s IPCO, Germany is the technology provider and process licensor of the WPU. The technology involves an efficient and cost- effective process, in which molten liquid wax is converted into pastille form (5 to 6mm size). Pallet Wax from Wax Pastillation Unit will cater to additional demand from customers and will enhance flexibility in marketing of Paraffin Wax. This plant will also improve capacity utilization of Wax block as

existing ASPU is sensitive to maintenance.

4. Aq. Ammonia Project

NRL is setting up an Aqueous Ammonia plant to meet 10 TPD Aq. Ammonia requirement in Bio-refinery to maintain pH for proper performance of enzymes. It is noteworthy that NRL is going to produce Aq. NH₃(25%) from a waste NH₃ rich stream of sour water stripper utilizing technology that is developed jointly by NRL & EIL. Its target completion is in March, 2026.

Aq. Ammonia 25% (NH₃) production will reduce NOX generation from refinery. Moreover, this project will convert waste to value added by product.

5. Tail Gas Treating Unit (TGTU)

TGTU was successfully commissioned on 15th February 2024. TGTU technology with the trade name Eng SulfTG® is developed by EIL to effectively remove sulfur by recycling the unreacted sulfur components like H₂S, SO₂, COS, & Sulphur by converting to H₂S in Hydrogenator & recovering as Sulphur in the Claus section in Sulphur Recovery Unit (SRU). Claus process integrated with Tail gas treating unit (TGTU) is designed based on EngSulfTG® technology and can result in 99.9% removal of sulfur from acid gas & sour gas coming from amine regeneration & Sour water stripper units in refinery. This technology is also adopted in the NREP SRU.

With the commissioning of TGTU, SO_x emission of SRU has significantly decreased from 6000 ppm without TGTU to 100-300 ppm with TGTU. Accordingly, the Sulphur recovery efficiency has improved from 96.0% to 99.9% with additional production of sulphur of around 4 % & it has added to NRL's continuous endeavor towards a safe and clean environment.

6. Green Hydrogen

NRL has been playing a pivotal role amongst the Indian PSU to meet the Green Hydrogen Consumption Obligation (GHCO) as per the Govt. of India mandate. Green Hydrogen offers a renewable energy-based alternative for meeting Hydrogen requirements in fertilizer production and petroleum refining. This has the potential to reduce the country's dependency on fossil fuels, energy security, and a step towards achieving the Net Zero goal. NRL is setting up a 2.4 KTPA (16 MW) Alkaline Electrolyzer (AEL) to produce 300 Kg per hour of Green Hydrogen. The project is awarded to M/s Greenko ZeroC for implementation with Electrolyzer to be supplied by M/s John Cockril, Belgium. NRL will meet 5% of GHCO by 2024-25 after commissioning of the project.

7. Proposed Polypropylene Unit (PPU)

A high-severity Petro-FCC unit is being set up under NREP to produce propylene as a petrochemical feedstock. The proposed Polypropylene unit will produce 360 KTPA of polypropylene homopolymer from petrochemical feedstock. NRL has engaged M/s Lummus Novolen GmbH, Germany, as process licensor for the proposed 360 KTPA Polypropylene unit. Basic Engineering Design Package for the unit is already completed. For execution of the project, lining up of EPCM/ EPC is under progress.

Considering the impressive growth of polypropylene in the domestic market, the 360 KTPA Polypropylene unit will help NRL to venture into the petrochemical market. This will also increase NRL's Petrochemical Intensity Index (PII).

8. Initiative for solar power

In its pursuit of tapping new and renewable energy sources, a slew of initiatives has been taken up to utilize solar energy in the refinery and the township premises. 1000KWp Solar PV panel installed in all non-critical building rooftops inside the refinery in 2017-18. Also installed 20KW solar rooftop PV panels adjacent to the NRL marketing terminal. NRL has replaced conventional streetlights with solar-powered lights in several places in its township. NRL is extending its solar power initiative for the benefit of the nearby community, solar panels have been installed in nos. of nearby schools. In its foray into renewable energy, NRL has taken the initiative to install a 50 KW Solar power plant on the rooftop of the Corporate Office Building in Guwahati.

9. Initiative for mitigation of climate change and environmental sustainability

As an initiative for mitigation of climate change and ensuring environmental sustainability, NRL has undertaken a project for the development and construction of three Bamboo Nurseries in Assam to generate 60 lakh saplings to be planted in 15,000 hectares of land area. This will create a carbon sink to fix 2.6 lakh tonnes of CO₂ per annum. MoU was signed between NRL and PCCF & HOFF, Assam on 23rd Jan'2023 for the establishment of the 3 nurseries of 5 ha. each at a project cost of 9 Crore for the macro proliferation and nurture of tissue cultured Bamboo saplings which will be made available to the farmers in Assam and other neighboring states. The primary hardened bamboo saplings for the nurseries shall be supplied by M/s Chroma Biotech, Dibrugarh, a Startup promoted by NRL.

NRL further desires to participate in the Green Credit Programme (GCP) by taking up afforestation projects as per the GCP notified on 13th October 2023 by MoEF&CC seeks 'Environmental positive actions' from PSUs, private industries, non-profits, and individuals.

Research and Development (R&D) Activities:

NRL took a few initiatives to strengthen the research and development capability of the organization through partnerships with academia and research organizations. R&D activities presently pursued by NRL are as follows:

1. Green Activated Carbon from Bamboo Dust

NRL has established the 'NRL Centre of Excellence for Sustainable Materials' (NRL-CoE SM) at IIT Guwahati to undertake R&D activities focused on developing environmentally sustainable materials from various refinery and bio-refinery streams. On August 30, 2023, a Memorandum of Agreement was signed with IIT Guwahati to develop technology for producing marketable grade green activated carbon from bamboo dust. This bamboo dust will be generated during the preparation of bamboo chips for the 2nd Generation Bio-Refinery being set up by NRL through its JV company, Assam Bio-Refinery Private Limited. As part of the project, a demonstration plant with a capacity of 5 MT per batch will be established to produce green activated carbon by pyrolyzing bamboo dust. This R&D project also aims to develop technology for producing very high-grade chemically activated carbon, which has applications in the pharmaceutical, electronics, and mining industries.

2. R&D Collaboration with CSIR: NEIST

NRL entered into a framework collaboration with CSIR: NEIST for the Identification of critical research areas pertinent to microbial remediation, soil chemistry, functionalization of low-grade/ weight hydrocarbons and subsequent upgradation, training of scientists, technologists, and officials in specialized areas. As part of this collaboration, a project "Removal of Phenol from sour & strip water, its re-use and value addition" has been taken up at an estimated cost of ₹1.27 Crore for a total project duration of 2 years to reduce water footprint and to produce value-added chemicals. Under this project, lab scale demonstration 50 Litre batch size for phenol removal is successfully completed by designing and developing a hollow fiber membrane module. The design and fabrication of a pilot demonstration facility of 1 m³/hr size is ready for demonstration at the NRL site.

In line with NRL's 10-year vision plan entailing a move to broader energy plays, Numaligarh Refinery Limited (NRL) inked a Memorandum of Agreement (MoA) on 27th December 2023, with Northeast Institute of Science and Technology, (NEIST) Jorhat, Assam, which is a constituent unit of the Council of Scientific and Industrial Research (CSIR). As per the MoA, NRL will engage with NEIST to set up an R&D Centre to be called "NRL-NEIST R&D Centre" (NRDC) at NEIST, Jorhat, aiming for a long-term collaboration to conduct research activities in emerging energy sectors. The objectives of the collaboration would be to create a state-of-the-art R&D, analytical, and testing platform for the petroleum industry to develop sustainable solutions to

the complex energy and environmental issues faced by the oil and petroleum industry through continuous and collaborative R&D and explore new frontiers in technology for tapping unconventional reserves of energy. It would also develop facilities for specialized testing of hydrocarbon, chemical samples, water samples as well as specialized testing for civil, mechanical, electrical, instrumentation and metallurgy tests. NRL and CSIR-NEIST jointly identified the following project proposals in first phase:

- Development of Sustainable Nanocomposite Membrane for CO₂-capture from PSA off gas.
- Development of Hybrid nano-catalyst for green Hydrogen Production for water electrolysis
- Production of high-quality graphene-like nanomaterials from petroleum waste of Northeastern Region and their functionalization
- Development of lignocellulolytic multienzyme production process for bamboo based biorefinery.

3. NRL Centre of Excellence for Sustainable Material at IIT Guwahati:

As a positive development, NRL has joined hands with Indian Institute of Guwahati (IITG) to develop Bio-degradable plastics from oil and bio refinery streams. An R&D project with a financial involvement of Rs. 4 Crore has been identified as the first project to be taken up. Earlier, an Memorandum of Understanding (MoU) was signed between NRL and IITG on 13th September 2019 for establishing 'NRL Centre of Excellence on Sustainable Materials (NCESM)' in Guwahati.

Presently the centre is carrying out research activities on "Development of Biodegradable Plastics from Oil and Bio-Refinery Streams". Development of indigenous technology for production of biodegradable plastic will help in replacing non-biodegradable polyethylene based packaging and contribute towards reduction of pollution from solid waste. Bio-degradable plastic will be a value added stream for the Bio Refinery. The aim of the project is to convert "Furfural", one of the by-products of the ABRPL, to biodegradable polymer "Polycaprolactone (PCL)".

Recently, a translational facility is set up at NRL CoE for housing a pilot plant on Bio-degradable polymer with a range of equipment related to downstream processing of bio-degradable plastics such as Blown Film Machine, Injection Moulding, Thermoforming, Cast Film Extruder etc. The pilot plant has the facility to manufacture a wide variety of items, including carry bags, toys, cutlery, decorative items etc. both from normal and biodegradable polymers.

4. Research Project at St. Edmund's College, Shillong

NRL has engaged St. Edmund's College, Shillong for research study on Utilization of cyanobacteria in the bioremediation of crude oil, hydrocarbon storage tank bottom sludge, and ETP hydrocarbon sludge and its environmental biotechnology implications at an estimated cost of ₹83 Lakh.

The aim of this project is Utilization of cyanobacteria in the bioremediation of crude oil, hydrocarbon storage tank bottom sludge, and ETP hydrocarbon sludge. Under this project,

significant development on the culture of cyanobacteria samples collected from NRL has been achieved and a bio-accumulation study with the cultured bacteria on hydrocarbon sludge is being investigated. The total petroleum hydrocarbon (TPH) profile of the treated cultures on the 28th day showed complete removal of the hydrocarbons from C11 to C48 which is the most remarkable achievement of the project.

5. R&D Collaboration with CSIR IIP Dehradun

A project titled “Studies for Efficient Utilization of UCO stream generated from upcoming Ebullated Bed (EB) Resid Hydrocracker under Numaligarh Refinery Expansion Project” has been taken up to carry out studies to convert un-converted oil (UCO) into value added products or specialty products like Bitumen.

6. Projects taken up in collaboration with BPCL Corporate R&D Centre (CRDC), Noida

NRL is currently collaborating with BPCL CRDC, Noida in two R&D projects:

- Production of Furfural Alcohol (FA) and Tetra Hydro Furan (THF) from Furfural: Furfural will be one of the by-products from bio-refinery. CRDC is currently developing technology for production of Furfural Alcohol and Tetra Hydro Furan from Furfural.
- Measuring efficacy of Enzymes of various suppliers for conversion of bamboo pulp into glucose by hydrolysis process.

7. Scientific and Technical Collaboration with Engineers India Limited

As per Govt. of India, guidelines on collaborative research and development (R&D) among PSUs, NRL and EIL have entered into a Memorandum of Understanding (“MOU”) dated 31.03.2022 to exchange scientific knowledge, encouraging joint research in the field of hydrocarbon, petrochemicals, energy technology, and commercialize such jointly developed technologies. Both parties have already identified a list of projects for joint development of its technology with a separate Memorandum of Agreement having defined objectives, scope of work, roles of parties, deliverables, cost and royalty sharing, etc.

NRL and EIL had entered into a Memorandum of Agreement (MoA) for the joint development and commercialization of technology for the Production of Aqueous Ammonia from ammonia-rich sour gases. NRL intends to recover the Ammonia from NREP- SRU Ammonia- Rich Sour Gases and produces Aqueous Ammonia as value added product. NRL has a readymade market for Aqueous Ammonia in ABRPL, situated adjacent to NRL, as around 10 -16 TPD of Aqueous Ammonia will be consumed in the Bio-Refinery process of ABRPL. In this regard, a basic engineering design package is being developed by EIL for the commercialization of EIL’s already developed patent through the setting up of a demonstration plant for the Production of aqueous ammonia from ammonia-rich sour gases in NRL refinery premises. It is envisaged that the Aqueous Ammonia project will significantly reduce NOX releases into the atmosphere. Moreover, this project will convert waste into value-added by-products.

Above Ground Sulphur Seal will be designed to handle 70 Kg per hour of liquid Sulfur flow to install at SRU of NRL using EIL's expertise on designing above Ground Sulphur Seal. Development and commercialization of Overground Sulphur Seal technology will help refineries to improve liquid–gas phase separation of liquid Sulphur in Sulphur Recovery Units. This will also lead to a reduction in SOX emissions.

8. Research Collaboration with Kaziranga University and Institute of Frontier Science and Application:

NRL has signed a Memorandum of Agreement (MoA) dated 16th June 2023 with Kaziranga University (KU) and the Institute of Frontier Science and Application (IFSA) for collaboration to carry out a research project titled 'Assessment of Wind Energy Potential in North-East India'. The collaboration is a first of its kind for the systematic exploration of wind energy potential in Northeast India. As per the MoA, Kaziranga University, in technical collaboration with the Institute of Frontier Science and Application (IFSA) and funding from NRL, will implement the project which aims to develop bankable wind energy assessment data over North-East India in riverine environment using mobile Lidar observations for a period of three years.

Assessment of Wind-Energy Potential using LIDAR technology through multi-level and multi-site high-frequency observation and Analysis in the Riverine Environment at the Turbine Level will provide a bankable wind-energy database for Assam relevant for viable wind energy installation. The results of the project can be used to catalyze commercial wind energy generation in Assam. The project thus has huge potential for significant socio-economic benefits for Assam. With the present project as a proof-of-concept, it can also be easily scaled up to cover wider areas of the North-East.

9. Indigenous Isomerization Catalyst:

The indigenous isomerization catalyst once developed would be manufactured by third-party manufacturers in India. Successful implementation of this R&D scheme will lead to an increase in indigenous capabilities for manufacturing such items that are presently procured from foreign manufacturers. Besides reducing dependency on foreign vendors, this initiative will give a fillip to the Make-In-India mission of the Government.

Projects of NRL:

On-going Projects

1. Numaligarh Refinery Expansion Project (NREP)

Numaligarh Refinery Expansion Project (NREP) is for the capacity expansion of the existing Refinery from the present 3 MMTPA to 9 MMTPA. The NREP consists of 02 major components, the Refinery Expansion with a new train of process units (6 MMTPA) and the Paradeep-Numaligarh Pipeline along with the Crude Oil Import Terminal (COIT) at Paradeep (1630 km, 9 MMTPA).

The Cabinet Committee on Economic Affairs (CCEA) of the Government of India accorded investment approval for the project on 16.01.2019. Environmental Clearance (EC) for setting up the new train of refinery of 6 million capacity was accorded by the MoEFCC on 27.07.2020. EC-CRZ clearance for COIT was received on 19th May 2021. Financial closure for the expansion project has been achieved on 30-12-2021.

The NREP project is being executed using a mixed implementation model comprising EPC, EPCM, PMC, and BOO contracts. Process units like CDUVDU, DHDT, MS Block, SRU, etc. are planned to be set up through EPC contracts. Few critical and complex units like RPTU and PFCC are planned to be set up in EPCM mode. The Hydrogen Generation Unit (HGU) will be set up in BOO mode. NRL will consider the green hydrogen option while sizing its hydrogen unit.

The overall progress of NREP as of 31st Mar 2024 is 60.45%. Progress for the refinery scope of jobs is 55.2% while progress for the pipeline scope of jobs is 69.04%. The project is expected to be completed by December 2025.

2. Petrochemical Project for NRL:

NRL is setting up a Petrochemical Complex to produce 360 KTPA of homopolymer grade polypropylene by leveraging on the capability to produce high-value petrochemical feedstock from NRL's 6 MMTPA new refinery (NREP) presently under implementation. The project will consist of a polypropylene production unit & dispatch facilities, along with associated utility systems. The investment approval for the project was obtained in March 2022. The polypropylene plant will utilize propylene as feedstock, which will be made available from high severity Petro-FCC of NREP. Once implemented, the integration of petrochemicals with the refinery will provide significant value addition to the complex. Considering the impressive growth of polypropylene in the domestic market, the 360 KTPA Polypropylene unit will help NRL to venture into petrochemical market. This will also increase NRL's Petrochemical Intensity Index (PII). NRL has engaged **M/s Lummus Novolen gmbh**, Germany, as process licensor for the proposed 360 KTPA Polypropylene unit. The Basic Engineering Design Package for the unit is already completed.

Joint Ventures and Associate Companies of NRL

NRL has three joint venture companies and one associate company:

1. Indradhanush Gas Grid Limited (IGGL)

IGGL is a joint venture company among Numaligarh Refinery Limited (NRL), M/s Oil India Limited (OIL), M/s Oil and Natural Gas Corporation Limited (ONGC), M/s Indian Oil Corporation Limited (IOCL) and M/s GAIL(India) Limited (GAIL) and was incorporated on 10th August 2018 to implement the North East Gas Grid project envisaged in the Hydrocarbon Vision 2030 for North East of Govt. of India. NRL is a partner with 20% stake in Indradhanush Gas Grid Limited (IGGL) which is executing Natural Gas Pipeline of 4.75 mmscmd capacity. The project will establish gas grid connectivity in the eight North-Eastern States, viz. Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim with the National Gas Grid through the Barauni-Guwahati Gas Pipeline Overall physical progress of the project as on 31st March, 2024 was 80.4%.

2. Duliajan Numaligarh Pipeline Limited (DNPL)

DNP Limited is a Joint Venture Company between Assam Gas Company Limited (AGCL), Oil India Limited (OIL) and Numaligarh Refinery Limited (NRL) and was incorporated on 15th June 2007 with an authorized share capital of ₹170.00 Crore. The present shareholding of the Company as on 31st March 2024 stands at AGCL (51%), NRL (26%) and OIL (23%). The registered office of the Company is at Guwahati, Assam with its operational headquarters at AGCL, Duliajan. The company started transportation of natural gas from Oil India Limited's installation in Duliajan to Numaligarh Refinery from March, 2011 onwards. DNP Limited undertakes transportation of natural gas through a pipeline having a design capacity of 1.2 MMSCUM of natural gas per day from Madhuban at Duliajan to NRL Refinery. During the year 2023-24, the Company transported 2,89,155 TSCM of natural gas as against 3,08,767 TSCM of natural gas in 2022-23.

3. Assam Bio Refinery Private Limited (ABRPL)

Country's first 2G bamboo based bio refinery being executed through a JV with Finnish collaborators ***"Assam Bio Refinery Private Limited"*** has recorded adequate progress on ground.

Assam Bio Refinery Private Limited was incorporated on 4th June, 2018 as a joint venture company promoted by NRL with 50% equity and balance 50% by Fortum 3.B.V Netherland and Chempolis Oy, Finland for producing ethanol from cellulosic feedstock 'Bamboo' which is available in abundance in North-Eastern (NE) states of India. The Project envisages using 300 Kilo-Tones Per Annum (KTPA) of dry bamboo (500 KTPA of green bamboo) as raw material and shall produce Cellulosic Ethanol, Acetic Acid, Furfuryl/Furfuryl Alcohol, along with combustible residue in the form of Bio coal and Stillages. The technology being used is based on selective fractionation of biomass and coproduction of multiple products. It shall produce approx. 49,000 Tones Per Annum (TPA) of bio-ethanol, 11,000 TPA of acetic acid and 18,000 TPA of furfural alcohol. Bamboo residue shall be used as fuel to produce steam and electricity. The Project Construction activity at the site was started in late 2018 and is continuing with major civil and structural works going on. Engineers India Limited (EIL) has been appointed as the

Engineering, Procurement and Construction Management (EPCM) consultant on August 24, 2018. Civil & Structural works at the site is continuing in full swing and manufacturing works at vendors' locations are also progressing well. Overall physical progress of the project as on 31st March, 2024 was 94.0%. The Project schedule has been revised with commissioning by December, 2024.

4. Brahmaputra Cracker and Polymer Limited (BCPL):

BCPL is an associate company incorporated on 8th January, 2007 as a Central Public Sector Enterprise under the Department of Chemicals & Petrochemicals, Government of India with an authorized share capital of ₹2,000 Crore to implement the Assam Gas Cracker Project in the district of Dibrugarh, Assam. GAIL (India) Limited is the main promoter having 70% of equity participation while Numaligarh Refinery Limited (NRL), Oil India Ltd (OIL) and Government of Assam are holding 10% share each. The plant was commissioned on 2nd January, 2016 and dedicated to the nation by the Hon'ble Prime Minister, on 5th February, 2016. The principal end products of the Company are High Density Polyethylene (HDPE) and Linear Low Density Polyethylene (LLDPE). The other products include Hydrogenated Pyrolysis Gasoline and Pyrolysis Fuel Oil.
